HAZARDOUS
SITE CONTROL
DIVISION

Remedial Planning/ Field Investigation Team (REM/FIT)

ZONE II

CONTRACT NO.
68-01-6692

CH2M HILL

Ecology & Environment

137653

000.0

REMEDIAL ACTION MASTER PLAN
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS

01-5VA5.0

October 17, 1983

ENFORCEMENT CONFIDENTIAL

REMEDIAL ACTION MASTER PLAN
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS

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October 17, 1983

Prepared By
CH2M HILL

PD224.040.1

REMEDIAL ACTION MASTER PLAN
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS

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Section 1
EXECUTIVE SUMMARY

This document is a Remedial Action Master Plan (RAMP) for the Johns-Manville site in Waukegan, Illinois. A RAMP is a plan for undertaking Remedial Investigation/Feasibility Study (RI/FS) activities and remedial actions in response to a hazardous substance release, or a substantial threat of release, into the environment. It is based on the National Oil and Hazardous Substances Contingency Plan (NCP) promulgated by the U.S. Environmental Protection Agency (USEPA) on July 16, 1982 (47 CFR 31180-31243).

1.1 PURPOSE

The purpose of this RAMP is to summarize the existing conditions at the Johns-Manville site and to define the scope of Initial Remedial Measures (IRMs), RI/FS activities, and remedial actions for the Johns-Manville site, along with a schedule of implementation. The RAMP was prepared from existing information and data only; no new data have been generated. It provides preliminary cost estimates for each proposed activity and identifies data limitations, community relations strategies, and possible problems during project implementation.

1.2 SITE LOCATION

The Johns-Manville site is located on the west shore of Lake Michigan in Waukegan, Illinois, about 37 miles north of Chicago and 10 miles south of the Wisconsin border. The site visit report, dated July 19, 1983, appears in Appendix A to this RAMP.

1.3 PROBLEM STATEMENT

The Johns-Manville plant produces and has produced a wide range of building materials. Hazardous wastes generated during production of the various materials include, but may not be limited to, asbestos, chromium oxide, lead, thiram, and xylene. The most significant known threat to public health and safety is the potential contamination by airborne asbestos. There are also potential threats to public health and safety from chromium oxide, lead, thiram, and xylene.

1.4 INITIAL REMEDIAL MEASURES

At the Johns-Manville site, the existence of a significant health or environmental hazard has not been clearly identified. The extent of the potential contamination would be determined during the RI/FS activities. Since the potential for direct contact with asbestos exists, an IRM consisting of installing warning signs is recommended.

1.5 REMEDIAL INVESTIGATION/FEASIBILITY STUDY

Existing data on the Johns-Manville site are inadequate to fully characterize contamination at the site. The RI is directed toward identifying and quantifying sources of contamination through field-oriented activities. The following field activities are recommended at the Johns-Manville site:

- Topographic survey
- Soil sampling and analysis
- Groundwater monitoring well installation
- Groundwater quality sampling and analysis
- Ambient air quality sampling and analysis review

The FS is directed toward developing and evaluating remedial action alternatives based on the results of the RI. The recommended alternatives would be technologically feasible and reliable. They would also effectively mitigate and minimize damage to and provide adequate protection of public health, welfare, and the environment.

The community relations assessment outlines suggested actions to be taken during RI/FS activities. Public interest in the site appears to be low.

Table 1-1 is a summary of the preliminary cost estimates for the IRM and RI/FS tasks. The costs given for the RI/FS do not include additional monitoring well installation, sampling, analysis, or additional ambient air quality sampling and analysis, should they be necessary. The description of each RI/FS task provides the basis for the associated costs.

The preliminary cost estimates have been prepared from information available at the time of the estimates. They should be used only for guidance in project evaluation and implementation. The final costs of the project will depend on actual labor and material costs, competitive market conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented herein. Because of this expected discrepancy, project feasibility and funding needs must be carefully reviewed before project funds are expended. This review will help ensure that the project is accurately evaluated and funded.

Table 1-1

ESTIMATED COSTS FOR INITIAL REMEDIAL MEASURES
AND REMEDIAL INVESTIGATION/FEASIBILITY STUDY
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Item	Estimated Cost Range Minimum	Estimated Cost Range Maximum
Warning signs	$ 1,100	$ 1,600
Task 1: Work plan preparation	33,900	51,000
Task 2: Site definition activities	25,700	38,500
Task 3: Detailed site characterization studies	162,700	226,500
Task 4: Site evaluation	22,900	34,400
Task 5: Remedial investigation report	21,300	31,900
Task 6: Alternative remedial action evaluation	35,600	53,400
Task 7: Feasibility study	12,300	18,400
Task 8: Conceptual design	15,200	22,800
Task 9: Project management	20,300	30,400
Total	$351,000	$508,900

Section 2
DATA EVALUATION

2.1 OBJECTIVE

This section summarizes available technical data and background information on the Johns-Manville site and its surrounding area, as well as the potential effects resulting from site contamination.

2.2 BACKGROUND DATA

2.2.1 Site Description

The Johns-Manville site is located on the west shore of Lake Michigan in Waukegan, Lake County, Illinois, about 37 miles north of Chicago and 10 miles south of the Wisconsin border (Figure 2-1). The site is bordered on the east by Lake Michigan; on the south by Commonwealth Edison Co.; on the west by railroad tracks operated by Chicago & North Western Transportation Company (C&NW) and the Elgin, Joliet, & Eastern Company (EJ&E), and by a residential area; and on the north by Illinois Beach State Park (Figure 2-2).

Johns-Manville's property covers about 300 acres of land. About 50 acres of vacant land are in the northwest portion of the property, 130 acres are occupied by the process buildings and other improvements, and 120 acres have been used for dumping of waste materials since the early 1920's. The main disposal area is located on the eastern part of the property (Figure 2-2). Access to the site is from Greenwood Avenue.

2.2.2 Plant Description

The Johns-Manville plant produces and has produced a wide range of building materials composed of a variety of substances. During 1922 to 1923, it made low-temperature pipe coverings, packing, insulating cements, roofing products, asbestos and rag felt papers, and magnesia and asbestos shingles. Since 1923, the plant has also produced asphalt floor tile, roofing felts, Sanacoustic tile, asbestos-cement pipe, cut gaskets, siding shingles, flexboard, wallboard, clapboard, rock wool, and glass fiber shingles. Hazardous waste generated during production of the various materials includes, but may not be limited to, asbestos, chrome, lead, xylene, and thiram (Document No. 019).

Almost all of the wastes generated since 1922 have been disposed of onsite. There are currently four general waste disposal areas: the friable asbestos disposal pit, the scrap disposal area, the wet waste basin system, and the sludge

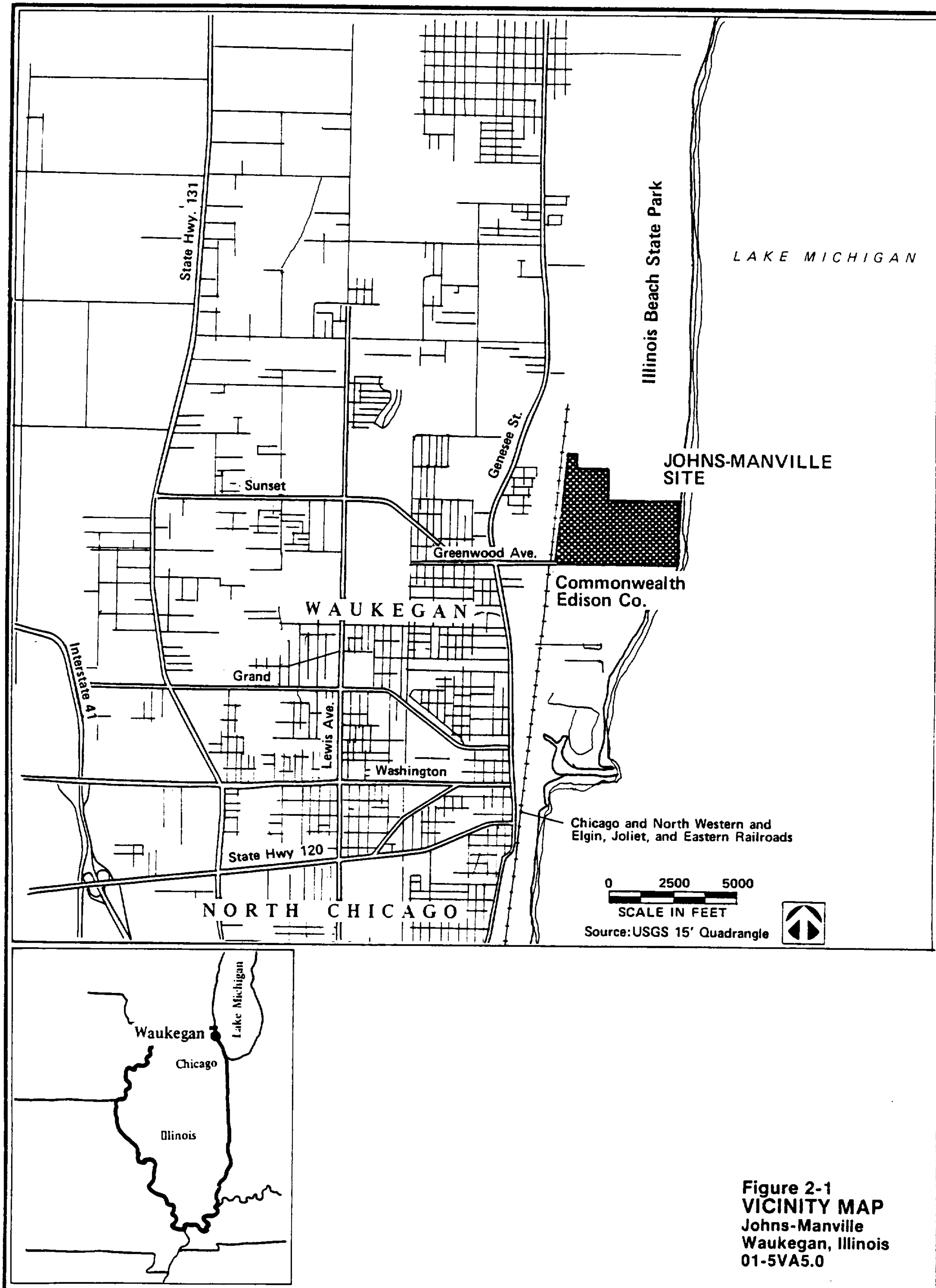

Figure 2-1
VICINITY MAP
Johns-Manville
Waukegan, Illinois
01-5VA5.0

W65005.00

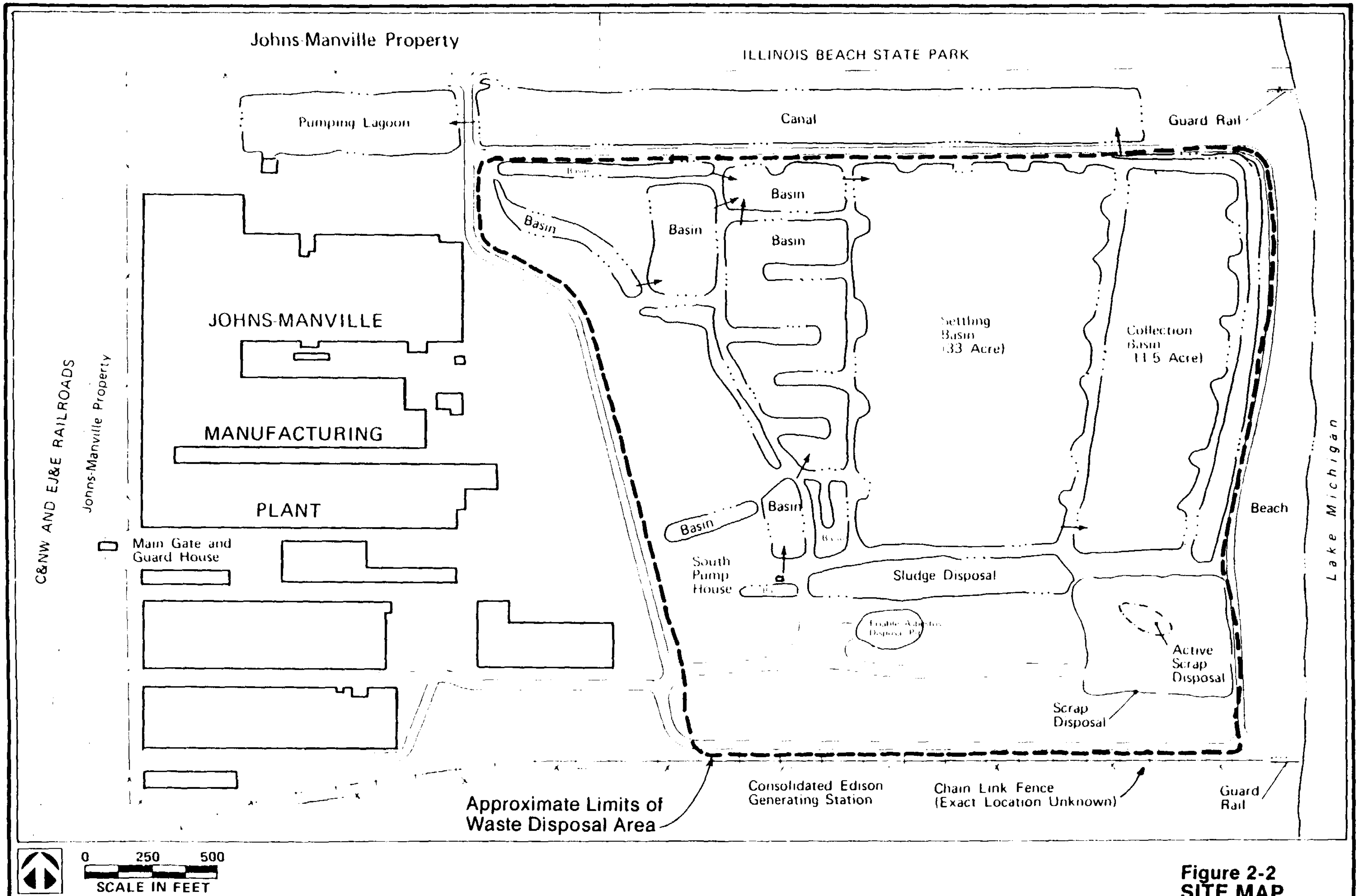

Figure 2-2
SITE MAP
Johns-Manville
Waukegan, Illinois
01-5VA5.0

W65005.00

disposal area. The friable asbestos disposal pit is where asbestos waste must be managed under the requirements of National Emission Standards for Hazardous Air Pollutants (NESHAPS). The friable asbestos disposal pit is managed so that no visible emissions to the outside air occur. The scrap disposal area is where loose and baled scrap products are dumped in the open. The wet waste basin system consists of a series of settling basins that do not discharge to navigable waters. The settling basins are not lined or sealed. The sludge disposal area is a dry depression where dredge spoils from the wet waste basins are discharged. Some combustible waste materials were incinerated between 1967 and 1971. Since 1967, efforts have been made to recycle waste material whenever possible (Document No. 019).

2.2.3 Chronology

The following site chronology is intended to serve as a general summary and order of known activities at or concerning the site. It is a date-by-date compilation of information obtained by reviewing correspondence, reports, and documents pertinent to the site. CH2M HILL compiled this information from the files of USEPA (Region V Office and Field Investigation Team) and Illinois Environmental Protection Agency (IEPA). This chronology is not intended to be a complete record of activities of all concerned parties.

For cross-reference purposes, each entry has been labeled with a document number. This number reflects its source of origin in the CH2M HILL files. In addition, each entry has been assigned a key word to quickly characterize the type of event discussed in the entry.

CHRONOLOGICAL FILE

Date: 00/00/20
Document No.: 003
Key Word: Site Data
Description: Mr. Wilcox, Johns-Manville plant supervisor, indicated at a January 8, 1980, meeting that Johns-Manville had been dumping wastes at the site since about 1920.

Date: 05/24/73
Document No.: 036
Key Word: Site Data
Description: The Division of Water Pollution Control issued Johns-Manville an operating permit for its closed loop recycle system. This system consisted of a series of settling basins with no surface water discharged to state waters.

Date: 09/00/74
Document No.: 018
Key Word: Sampling/Testing
Description: The Illinois Institute of Technology Research Institute (IITRI) report, "Characterization and Control of Asbestos Emissions from Open Sources" (Report No. PB-238925), dated September 1974, documents asbestos upwind and downwind of the Johns-Manville site. The field ambient air samples were collected on December 8, 1973. The results were analyzed by both electron microscope and optical microscope methods.

Date: 08/00/75
Document No.: 001
Key Word: Site Data
Description: The Division of Water Pollution Control, IEPA, Maywood Office, performed an inspection of the Johns-Manville site in August 1975. Mr. Joseph F. Petrilli, Division of Land/Noise Pollution Control, IEPA, found that a permit from the Division of Water Pollution Control was not required because there were no apparent discharges to the state waters.

Date: 10/25/77
Document No.: 001
Key Word: Site Data
Description: Messrs. Wengrow and Petrilli, Division of Land/Noise Pollution Control, IEPA, performed an inspection of the Johns-Manville site on October 25, 1977. They found that the site was in violation of the IEPA Act and Chapter 7 of the Illinois Pollution Control Board Rules and Regulations on Solid Waste.

Date: 11/09/77
Document No.: 001
Key Word: Site Data
Description: Mr. Joseph F. Petrilli, Division of Land/Noise Pollution Control, informed Messrs. Mutaw and Wikel, Johns-Manville, that a permit would be required for disposal of a special waste on Johns-Manville property (asbestos and possibly liquid discharges).

Date:	02/23/78
Document No.:	002
Key Word:	Site Data
Description:	Ms. Jean I. Larsen, Illinois State Geological Survey, Northeastern Illinois Office, provided Mr. Robert Wengrow, Division of Land/Noise Pollution Control, IEPA, with information concerning the hydrogeologic conditions at the Johns-Manville site.

Date:	06/00/79
Document No.:	003
Key Word:	Site Data
Description:	Mr. Scott, Johns-Manville plant manager, indicated at the January 8, 1980, meeting that the Transite pipe operation was discontinued in June 1979.

Date:	01/08/80
Document No.:	003
Key Word:	Site Data
Description:	Mr. Sudhir Desai and Ms. Mary Wang Schroeder, IEPA, visited the Johns-Manville site on January 8, 1980. They observed the roofing paper-shingle, particle board, and insulation processes. After observing the processes, Mr. Desai indicated that he believed Johns-Manville was in compliance with the Division of Air Pollution Control regulations. At the meeting, information was discussed concerning plant operation.

Date:	12/09/81
Document No.:	005
Key Word:	Site Data
Description:	Mr. Kenneth P. Bechely and Ms. Mary Wang Schroeder, IEPA, visited the Johns-Manville site on December 9, 1981. Mr. Van Dyke, Johns-Manville safety and health coordinator, indicated that the papermill operation has been discontinued. At the meeting, information was discussed concerning the landfilling operation. At this inspection, the site appeared to be in compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAPS).

Date: 01/13/82
Document No.: 004
Key Word: Site Data
Description: Mr. Kenneth P. Bechely, IEPA, indicated to Mr. Donald Gimbel, IEPA, that the Johns-Manville site may be required to obtain a permit for its landfill.

Date: 04/28/82
Document No.: 006
Key Word: FIT
Description: Ecology and Environment, Inc., performed a field investigation at the Johns-Manville site. They collected airborne asbestos samples at upwind, midsite, and downwind locations. Their conclusion was that the site appears to meet requirements for a positive air emission in the Hazard Ranking System Model.

Date: 05/24/82
Document No.: 009
Key Word: Sampling/Testing
Description: EMS Laboratories, Inc., data summary sheets for airborne asbestos samples A1613 through A1618, collected on April 28, 1982.

Date: 08/12/82
Document No.: 008
Key Word: Site Data
Description: Mr. Norm Niedergang, USEPA, calculated the Hazard Ranking System (HRS) score for the Johns-Manville site.

Date: 11/22/82
Document No.: 013
Key Word: Site Data
Description: Mr. Norm Niedergang, USEPA, and Messrs. Sudhir Desai and Brad Benning, IEPA, visited the Johns-Manville site on November 22, 1982. The purpose of the visit was to observe a potential Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) candidate. Mr. Niedergang discussed the results of the April 28, 1982, Field Investigation Team (FIT) study, and he recommended that a full field investigation be conducted to include both air and bulk soil sampling.

Date: 12/03/82
Document No.: 012
Key Word: Site Data
Description: Georgi A. Jones, Department of Human Services, informed USEPA Region V that "...due to less than optimum sampling and analytical techniques, the degree of health risk from this site cannot be estimated with any certainty." He suggested collecting additional data and analyzing them by a different method.

Date: 12/30/82
Document No.: 017
Key Word: Site Data
Description: On December 30, 1982, Johns-Manville was listed on the National Priorities List, 47 Federal Register 58476.

Date: 02/07/83
Document No.: 014
Key Word: Site Data
Description: USEPA requested additional information from the registered agent for Manville Service Corporation pertaining to their Waukegan, Illinois, facility.

Date: 02/28/83
Document No.: 017
Key Word: Site Data
Description: Ms. Carolyn A. Lown, Schiff Hardin & Waite, provided Mr. Norm Niedergang, USEPA, with a copy of the comments submitted to USEPA on behalf of Johns-Manville Sales Corporation concerning the proposed National Priorities List, 47 Federal Register 58476 (December 30, 1982).

Date: 04/07/83
Document No.: 019
Key Word: Site Data
Description: Ms. Carolyn A. Lown, Schiff Hardin & Waite, provided Mr. Basil G. Constantelos, USEPA, with a response to USEPA's letter dated February 7, 1983, requesting information about the waste disposal practices at the Johns-Manville facility in Waukegan, Illinois.

Date:	06/01/83
Document No.:	036
Key Word:	Sampling/Testing
Description:	Mr. Kevin Pierard, Weston, Inc. (a contractor for USEPA), conducted an inspection of the disposal site on June 1, 1983. During the inspection, 39 photographs were taken and two water samples were collected. The samples are in storage and no analysis has been conducted.
Date:	06/20/83
Document No.:	034
Key Word:	Sampling/Testing
Description:	Johns-Manville submitted an independent review of the air sampling for asbestos conducted on April 28, 1982, by Ecology and Environment, Inc.
Date:	06/21/83
Document No.:	036
Key Word:	Site Data
Description:	IEPA conducted a multimedia inspection of the Johns-Manville site on June 21, 1983. Representatives were present from the Division of Land, Water, and Air Pollution Control. Three surface water samples were collected. The samples will be analyzed for heavy metals. Results will be available in mid-August 1983.
Date:	07/13/83
Document No.:	036
Key Word:	Site Data
Description:	On July 13, 1983, Mr. Sudhir Desai, IEPA, visited the Johns-Manville site to observe the transport and disposal of asbestos wastes and to determine whether Johns-Manville was in compliance with NESHAPS.
Date:	07/19/83
Document No.:	035
Key Word:	Site Data
Description:	Ms. Carolyn A. Lown, Schiff Hardin & Waite, submitted information to Mr. James R. Schneider, CH2M HILL, that updated certain material provided to Mr. Basil G. Constantelos, USEPA, on April 7, 1983.

2.3 HAZARDOUS MATERIALS CHARACTERIZATION

2.3.1 Hazardous Material Sources

Hazardous materials known to be disposed of at the Johns-Manville site consist of the following: asbestos, chrome, lead, xylene, and thiram. In April 1973, a survey was conducted of the solid waste generated at the Johns-Manville Site. An estimate of the solid wastes containing asbestos generated before April 1973 and the solid wastes containing asbestos disposed of as of April 1973 are presented in Tables 2-1 and 2-2, respectively. An estimate of the hazardous wastes generated and disposed of onsite before August 18, 1980, is presented in Table 2-3. An estimate of the hazardous wastes disposed of in an incorporated form (in trimmings from finished products, or in reject products) before August 18, 1980, is presented in Table 2-4. In addition, about 17,410 pounds of waste asbestos per month was contained in slurry that was going into the wet waste basin system (Document 019).

Since December 1980, monthly estimates have been made of the hazardous wastes disposed of in the onsite area. These estimates were not derived from any actual testing and should be considered gross estimates. The average monthly estimates between December 1980 and February 1983 are as follows (Document No. 019):

- Raw asbestos - 72 pounds for 27 months
- Chrome - 21 pounds for 10 months
- Lead - 1 pound for 18 months
- Xylene - 0 pound for 27 months
- Thiram - 41 pounds for 17 months

The chrome referred to in the above estimate was the chrome contained in chromic oxide and was used to produce chroma fiber. Chrome is not listed as a hazardous waste, but is a waste that exhibits the characteristics of EP toxicity. If the chrome exhibits EP toxicity, it is a hazardous waste for the purposes of the Resource Conservation and Recovery Act (RCRA) regulations. The only waste chromic oxide generated is that which may cling to the shipping containers and that which might be produced in the mixing area and collected in the dust house. The waste chromic oxide that is left in empty containers is not subject to RCRA regulation. The waste chromic oxide in the dust house would occur in small amounts because it is generally used only 2 months out of the year (Document No. 035). The lead that is referred to

Table 2-1

SOLID WASTES GENERATED BEFORE APRIL 1973
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Product	Annual Quantity	Estimated Percent Asbestos	Status
Auto and industrial lining	130,000 lb	55%	Discontinued 4/30/73
Brake blocks	315,000 lb	65	Discontinued 2/1/73
No. 6401 brake blocks	16,000 lb	39	Discontinued 2/1/73
1257 tan brake blocks	89,000 lb	65	Discontinued 2/1/73
Friction materials sludge	32,000 lb	60	Discontinued 5/1/73
#60 Service sheet	838,000 lb	80	Cut gasket discontinued 12/15/72; reject sheet sold at discount to gasket cutters
#61 Service sheet	200,000 lb	80	Cut gasket discontinued 12/15/72; reject sheet sold at discount to gasket cutters
Disc brakes	Included in F.M. sludge	60	Discontinued 4/30/73
Steel back clutch facings	10,000 lb	60	Discontinued 2/1/73
Transite pipe	5,800,000 lb or 2,900 tons	15	Recycled

Source: Document No. 019.

Table 2-2

SOLID WASTES DISPOSED OF AS OF APRIL 1973
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Product	Annual Quantity	Estimated Percent Asbestos	Status
Millboard	25,000 lb	80%	No sheet material
Flexboard and Transitop	2,250,000 lb	22	Trim, scrap, and dust
Saturating felt	5,472,000 lb or 2,736 tons	50	No use found
Asphalt roll roofing	13,344,000 lb or 6,672 tons	17	1/3 asbestos felt 2/3 organic felt
Transite pipe	8,748,000 lb or 4,373 tons dry	15	Excess of recycle
	572,000 lb or 286 tons wet	15	Wet end collector

Source: Document No. 019.

Table 2-3

HAZARDOUS WASTES GENERATED AND DISPOSED OF ONSITE
BEFORE AUGUST 18, 1980
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Substance	Monthly Quantity
Raw asbestos[a]	750 lb
Chromium	14 lb
Lead	4 lb
Xylene	300 lb
Thiram	1 lb plus 8 inner liners

[a]Raw asbestos is non-incorporated fibers.

Source: Document No. 019.

Table 2-4

HAZARDOUS WASTES DISPOSED OF IN AN ENCAPSULATED FORM
BEFORE AUGUST 18, 1980
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Substance	Monthly Quantity (lb)
Asbestos	14,190
Chromium	3,077
Lead	298
Thiram	136

Source: Document No. 019.

in the above estimate was used to produce sheeter materials. Lead is no longer used in the manufacturing process and no longer generated as a waste (Document No. 035).

The thiram referred to in the above estimate was that used in sheet manufacture and that which may cling to shipping containers. This thiram in the manufacturing process wastes is not considered to be a hazardous as defined by 40 CFR 261.33(f) waste regulated under RCRA. The thiram that is left in empty containers as defined by 40 CFR 261.7(b) is not subject to RCRA regulations (Document No. 035).

2.3.2 Sampling and Analysis

On December 8, 1973, ambient air samples were collected by the IITRI using a minimum sampling period of 3 hours. The results of the December 1973 sampling are presented in Table 2-5. Airborne asbestos samples were collected by Ecology and Environment, Inc., on April 28, 1982, using a minimum sampling period of 8 hours. The results of the April 1982 sampling are presented in Table 2-6.

On June 21, 1983, three surface water samples were collected by IEPA, Division of Water Pollution. The sampling results will be available about the middle of August.

2.3.3 Regulations

Asbestos is a hazardous air pollutant regulated under the Clean Air Act by NESHAPS (40 CFR 61B). The NESHAPS requirements for asbestos waste disposal sites (40 CFR 61.25) include the following:

- "There shall be no visible emissions to the outside air from any active waste disposal site where asbestos-containing waste material has been deposited....
- Warning signs shall be displayed at all entrances, and along the property line of the site or along the perimeter of the sections of the site where asbestos-containing waste material is deposited....
- The perimeter of the disposal site shall be fenced in order to adequately deter access to the general public....
- Warning signs and fencing are not required where the requirements of (the following)* paragraph... are met, or where a natural barrier adequately deters access to the general public....

*Words in parentheses have been added for regulatory simplification.

Table 2-5

SUMMARY OF AMBIENT AIR SAMPLING
DECEMBER 8, 1973
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Location	Sampling Elevation (meters)	Total Number of Fibers Per Cubic Meter	
		Optical Microscopy[a]	Electron Microscopy[b]
1 (upwind)	2	0.38×10^2	5.58×10^7
1 (upwind)	7	3.15×10^2	4.48×10^7
2 (midsite)	2	1.12×10^2	2.58×10^7
2 (midsite)	7	1.99×10^2	1.48×10^8
3 (downwind)	2	2.11×10^2	6.07×10^7
3 (downwind)	7	2.48×10^2	2.69×10^7

[a] Fiber size distribution from 1.5 to more than 30 micrometers.
[b] Fiber size distribution from 0.048 to 1.49 micrometers.

Source: Document No. 018.

Table 2-6

SUMMARY OF AIRBORNE ASBESTOS SAMPLING
APRIL 28, 1982
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Location	Sampling Elevation (feet)	Electron Microscopy (total number of fibers per cubic centimeter): Ecology and Environment		Johns-Manville	
		Coarse[a]	Fine[b]	Coarse	Fine
Upwind	5	0.70	0.02	-[c]	0.03
Midsite	5	12.00	0.20	3.0	0.09
Downwind	14	21.0	Below detection limit	4.8	0.05

[a]Coarse fiber size ranges from 2.5 to 15 micrometers.
[b]Fine fiber size is less than 2.5 micrometers.
[c]No data.

Source: Document Nos. 006 and 034.

- Rather than meet (the first)* paragraph of this section, an owner or operator may elect to meet the requirements of (one of the following)* paragraph(s)....

- At the end of each operating day, or at least once every 24-hour period while the site is in continuous operation, the asbestos-containing waste material which was deposited at the site during the operating day or previous 24-hour period shall be covered with at least 15 centimeters (ca. 6 inches) of compacted non-asbestos containing material.

- At the end of each operating day, or at least once every 24-hour period while the disposal site is in continuous operation, the asbestos containing waste material which was deposited at the site during the operating day or previous 24-hour period shall be covered with a resinous or petroleum based dust suppression agent which effectively binds dust and controls wind erosion...."

Asbestos is regulated for occupational exposure by the Occupational Safety and Health Administration (OSHA). The air quality standards and recommended criteria for asbestos are presented in Table 2-7.

Chromium and lead, as defined by 40 CFR 261.24, are regulated under RCRA if they exhibit the characteristics of EP toxicity. At this time, no EP toxicity tests have been run on either chromium or lead. To exhibit the characteristics of EP toxicity, the maximum concentration of contaminants for both chromium and lead is 5.0 milligrams per liter.

Xylene, as defined by 40 CFR 261.31, is regulated under RCRA as a hazardous waste from nonspecific sources. Xylene is a spent nonhalogenated solvent and exhibits characteristics of ignitability.

Thiram, as defined by 40 CFR 261.33, is regulated under RCRA as a toxic waste.

2.3.4 Criteria

For known carcinogens, the recommended maximum concentration for human health is zero. This criterion is based on the belief that there is no recognized safe concentration for humans. Because attaining a zero concentration level may

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*Words in parentheses have been added for regulatory simplification.

Table 2-7

AIR QUALITY STANDARDS AND RECOMMENDED CRITERIA FOR ASBESTOS
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Standard	8-Hour Time-Weighted Average[a] (f/cm^3)	Ceiling Concentration (f/cm^3)
OSHA[b] permissible exposure limit	2	10
NIOSH[c] recommended limit	0.1	0.5

[a] f/cm^3 = Fibers per cubic centimeter.
[b] OSHA = Occupational Safety and Health Administration.
[c] NIOSH = National Institute for Occupational Safety and Health.

Source: USEPA, 1980.

not be feasible, however, and to aid in future development of water quality regulations, USEPA is considering setting criteria at an interim target risk level based on cancer risk levels. For example, concentrations that have a risk level of 10^{-5} are estimated to result in an increase of one cancer death per 100,000 people who experience exposure over a lifetime. The USEPA Ambient Water Quality Criteria for protection of human health from ingestion of water are presented in Table 2-8 (USEPA, 1980).

2.4 ENVIRONMENTAL SETTING

2.4.1 Physiography

Lake County is in the Wheaton Morainal part of the Great Lake Section of the Central Lowland physiographic region (Bergstrom, 1976). The landscape of Lake County has been shaped by action of water and ice. At the Johns-Manville site, the local physiographic unit is the Lake Border Morainic System (Larsen, 1973).

The general topography surrounding the Johns-Manville site is level. The process buildings are on natural ground. The highest part of the disposal area is about 30 feet above natural ground. The surface topography of the waste area is irregular. In general, peripheral portions of the site slope away from the center of the site. In the vicinity of the wet basins, drainage is to the basins. Part of the south portion of the site slopes into closed depressions, such as the friable asbestos disposal pit, the scrap disposal area, and the sludge disposal area. The southwestern portion of the site slopes generally to the west. The southeastern portion of the site generally slopes east toward Lake Michigan.

2.4.2 Geology

The Wadsworth Till Member is the principal surficial deposit in Lake County and typically ranges in thickness from a few feet to more than 250 feet. It is generally characterized by a yellow or olive-brown color in the top 5- to 10-foot oxidized zone, and by gray color below the oxidized zone. The till is subdivided into two phases: a clayey phase and a somewhat sandy phase. In the eastern portion of Lake County, the clayey Wadsworth Till underlies the surficial deposits. The surficial deposits ranging in thickness from 5 to 40 feet consist of man-made landfill (mostly sand), grayslake peat (peat and muck), and nearshore lake sediments (sandy gravels) (Larsen, 1973, and Document No. 002).

The surficial deposits are underlain by Silurian-age Niagaran-Alexandrian dolomite (0 to 300 feet thick); Ordovician-age Maquoketa shale (125 to 225 feet thick), Galena-Platteville

Table 2-8

USEPA AMBIENT WATER QUALITY CRITERIA
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Substance	Toxicity (ppb)	Carcinogenicity[a] (f/l)
Asbestos	NCA	300,000
Chromium (total hexavalent)	50	NCA
Chromium (total trivalent)	170,000	NCA
Lead	50	NCA
Thiram	NCA	NCA
Xylene	NCA	NCA

ppb = Parts per billion.
f/l = Fibers per liter.
NCA = No criteria available.

[a]Carcinogenicity protection of human health from ingestion of water at the 10^{-5} risk level.

Source: USEPA 1980.

dolomite (275 to 325 feet thick), and Glenwood-St. Peter Sandstone (100 to 300 feet thick); Cambrian-age Potosi dolomite (50 to 100 feet thick), Franconia dolomitic sandstone and shale (50 to 75 feet thick), Ironton-Galesville sandstone (150 to 200 feet thick), Eau Claire siltstone, sandstone, shale, and dolomite (400 to 450 feet thick), and Mt. Simon sandstone (1,500 to 2,200 feet thick); and Precambrian-age granite. The bedrock surface generally dips to the east (Larsen, 1973).

At the Johns-Manville site, the surficial deposits are 30 to 50 feet thick and overlie 47 to 75 feet of silty clay till. Underlying the till is a 14- to 18-foot thick-layer of sand and gravel glacial drift overlying Silurian-age dolomite (Document No. 002).

2.4.3 Hydrology

The Johns-Manville site is on the Lake Michigan shore. This lakefront area is subject to storm waves and severe erosion that could damage the shoreline periodically (Larsen, 1973). Drainage at the Johns-Manville site is collected either in catch basins at the paved areas or in the wet waste basin system and recycled. At the south and east portions of the site, there may be surface runoff to Lake Michigan.

Water supplies for the City of Waukegan are drawn from Lake Michigan. After use, this water is returned to Lake Michigan in the form of treated effluent (Larsen, 1973).

2.4.4 Geohydrology

Groundwater resources are available everywhere in Lake County. The five major water-yielding units are: the glacial drift aquifers, the shallow dolomite aquifer (Silurian), the Glenwood-St. Peter sandstone, the Ironton-Galesville sandstone, and the Mt. Simon sandstone. The two aquifers closest to the surface, the glacial drift and shallow dolomite aquifers, form the shallow system and are replenished or recharged by local rainfall. The remaining three deep sandstone aquifers are recharged by precipitation seeping downward through the overlying rocks on a regional scale (Larsen, 1973).

In the northeast portion of Lake County, the glacial drift aquifer ranges from 15 to 50 feet in thickness and is buried underneath till. It generally produces small to moderate quantities of water. The shallow dolomite aquifer is about 200 feet thick and generally produces moderate to large quantities of water. The upper third of the dolomite is the most productive because of the numerous fractures, crevices, and solution cavities. The Ironton-Galesville sandstone aquifer is the most productive of the deep sandstone aquifers. It generally produces 1,000 gallons per minute (gpm) or more. The St. Peter sandstone produces moderate quantities of water. The Mt. Simon sandstone aquifer has the potential to produce large quantities of water. However, it is not generally economically feasible to develop this aquifer because the Mt. Simon aquifer occurs at great depths and becomes too saline for use without treatment (Larsen, 1973).

At the Johns-Manville site, four wells to the Silurian-age dolomite were drilled in 1920. The depth of these wells ranged from 108 to 132 feet below natural ground near the process buildings. The drift aquifer above bedrock was 14 to 18 feet in thickness. Two wells drilled in 1919 are located in the SW¼ of the NW¼ of Section 15, use the Silurian-age dolomite for water supply, and are 95 to 100 feet deep. One well, drilled in 1928 and also located in the SW¼ of the NW¼ of Section 15, uses the Mt. Simon sandstone aquifer and is 1,670 feet deep (Document No. 002).

The general groundwater movement at the Johns-Manville site is lateral and upward toward Lake Michigan.

2.4.5 Air Quality

Air quality in Lake County is generally good. As of July 1982, the area was classified as attaining the primary National Ambient Air Quality Standards (NAAQS) for criteria pollutants of total suspended particulates (TSP) and sulfur dioxide (SO_2). The area was classified as a nonattainment area for ozone (O_3) and cannot be classified for criteria pollutants of carbon monoxide (CO) and nitrogen dioxide (NO_2) (Federal Register, 1982). At the site, airborne asbestos samples were collected in December 1973 and April 1982 to determine whether airborne asbestos existed.

Battelle Columbus Laboratories has been contracted by USEPA's Office of Toxic Substances to evaluate data relative to air sampling and recommend further air quality monitoring. They recommend collecting additional samples for analysis. The results of their air sampling and analysis program are included in Appendix B.

2.4.6 Ecology

Plant, aquatic, and animal life in the area is probably typical of urban and waterfront areas. It is not known whether any plant, aquatic, or animal life surveys of the area have been conducted.

2.4.7. Socioeconomics

The Johns-Manville site is located in a primarily urban setting. The primary uses of the surrounding area are residential, industrial, and recreational. According to the 1980 census, the City of Waukegan has 67,653 residents.

2.5 ASSESSMENT OF POTENTIAL IMPACTS

2.5.1 Public Health and Safety

The most significant known threat to public health and safety posed by the Johns-Manville site is potential contamination by airborne asbestos. The ambient air sampling conducted on April 28, 1982, suggested that there was airborne asbestos above background levels downwind of the Johns-Manville site. Asbestos fibers can enter the human body by inhalation or ingestion.

Asbestos fibers found in human lungs are generally less than 5 micrometers in length; the largest fibers seldom exceed lengths of 200 micrometers or diameters of 3.3 micrometers (USEPA, 1982).

Asbestos fibers found in the gastrointestinal tract have entered it by ingestion of asbestos-contaminated water or food, or by swallowing inhaled asbestos fibers. About half of the asbestos inhaled will be swallowed (USEPA, 1982).

Most of the ingested asbestos is excreted in feces; however, microscopic fibers could migrate through the gastrointestinal mucosa (USEPA, 1982).

Exposure to airborne asbestos fibers has been shown to cause bronchial carcinoma (lung cancer), mesothelioma (a rare cancer of the membranes lining the chest and abdomen), and gastrointestinal tract cancers (throat, stomach, colon, rectum) (USEPA, 1982).

Long-term exposure could result in asbestosis, in which fibrous tissue is generated around the alveoli of the lungs and the thickened membranes impede the interchange of carbon dioxide and oxygen. Severely affected people develop shortness of breath and may die of heart failure (USEPA, 1982).

The Johns-Manville site also poses potential threats to public health and safety from chromium oxide, lead, thiram, and xylene. Chromium oxide is severely toxic when inhaled. Chromium compounds have a corrosive action on the skin and mucus membranes. Lead is a cumulative poison and can enter the body if one inhales dust, ingests lead compounds, or absorbs lead compounds through the skin. Thiram is severely toxic when ingested and moderately toxic when absorbed through the skin. It is not soluble in water. Xylene is moderately toxic when ingested or inhaled.

2.5.2 Environment

Asbestos from the Johns-Manville site could affect terrestrial life that may exist on and near the site. Terrestrial life may be adversely affected by ingesting or inhaling asbestos fibers.

2.5.3 Socioeconomics

The presence of airborne asbestos in an urban and lakeshore environment could cause socioeconomic impacts. These might include declines in property values, decreases in renter occupancy, declines in tourism and recreational activity, and decreases in industrial production because of sickness.

2.6 DATA LIMITATIONS

The following data limitations were noted in this RAMP:

- Physiographical Data. Topographic mapping of the vicinity is limited to United States Geological Survey 10-foot contour intervals at a scale of 1 inch equals 2,000 feet. Contours of the waste area are not shown.

- Geological Data. The extent of contamination in the surface deposits has not been defined.

- Hydrological Data. There is insufficient information to determine surface water drainage patterns. Results of the analysis of the surface water samples collected on June 21, 1983, will not be available until about the middle of August. These results may make it necessary to modify the scope of work proposed in this RAMP.

- Geohydrological Data. Groundwater quality in the drift or dolomite aquifers has not been defined, either horizontally or vertically.

- Air Quality Data. The extent of contamination from airborne asbestos fibers has not been fully defined. USEPA's Office of Toxic Substances has engaged an independent contractor to make recommendations concerning the need for and required methods of air quality sampling. Review of the results of this sampling may make it necessary to modify the scope of work proposed in this RAMP.

- Ecological Data. To our knowledge, the effects of asbestos fibers on the plant, aquatic, and animal life in the vicinity of the site have not been addressed by previous studies.

Section 3
REMEDIAL ACTIVITIES

3.1 REMEDIAL ACTION PLAN

The purpose of a RAMP is to identify, define, and schedule a set of activities necessary to implement remedial actions at an uncontrolled waste site. This RAMP has been prepared from existing information and may require revision as new information becomes available. Preliminary cost estimates are presented for activities that can be readily defined within the scope of this RAMP. However, these costs may also require revision as new data become available that would change the scope of the various activities outlined in the RAMP.

This RAMP encompasses the following general activities:

- IRMs to limit exposure or threat of exposure to a significant public health or environmental hazard
- An RI/FS to determine the nature and extent of the problem, to assess whether the threat can be mitigated and minimized by source control or offsite control, to develop and evaluate remedial action alternatives, and to recommend the most appropriate alternative based on cost, environmental effects, and engineering feasibility
- Source control remedial actions to reduce or remove hazardous substances from the site
- Offsite remedial actions to minimize and mitigate the migration of hazardous substances from the site

A master site schedule is presented in Figure 3-1. This schedule was developed with best estimates of the time required for each major task based on data currently available; however, actual project developments may cause elements of the schedule to shift chronologically or alter the activity durations.

3.2 INITIAL REMEDIAL MEASURES

3.2.1 Objective

In accordance with the NCP (40 CFR 300.68(e)(1)), IRMs are used to limit exposure or threat of exposure to a significant health or environmental hazard. At the Johns-Manville site, the existence of a significant health or environmental hazard has not been clearly identified. The extent of potential contamination would be determined during the RI/FS. Since potential for direct contact with asbestos exists, the following IRM is recommended:

- Warning signs along all of the fence adjacent to the site should be installed at 330-foot intervals to warn the general public of the asbestos waste disposal site.

3.2.2 Recommended Initial Remedial Measures

Warning Signs. It is recommended that warning signs be installed along all of the fence adjacent to the waste site. Warning signs would be installed at about 330-foot intervals as described by 40 CFR 61.25. The warning signs would state: ASBESTOS WASTE DISPOSAL SITE--DO NOT CREATE DUST--BREATHING ASBESTOS IS HAZARDOUS TO YOUR HEALTH. All letters should be 1 inch high. The proposed locations of the warning signs are shown on Figure 3-2.

For the purpose of providing a preliminary cost estimate, it is assumed that 11 warning signs, 20 by 14 inches, would be required.

3.2.3 Cost Estimate and Schedule

The preliminary cost estimate and schedule for the IRMs are presented in Table 3-1.

3.3 REMEDIAL INVESTIGATION/FEASIBILITY STUDY

3.3.1 Objective

"Wherever any hazardous substance is released or there is a threat of such a release...the President is authorized...to remove or arrange for removal of, and provide remedial action relating to such hazardous substance...." (CERCLA 104(a)(1)). At the Johns-Manville site, there is a potential threat to public health and safety posed by airborne asbestos and also by groundwater contamination from chromium oxide, lead, thiram, and xylene.

Existing data for the Johns-Manville site are inadequate to fully characterize the potential air and groundwater contamination at the site. An RI/FS is therefore warranted and necessary to fill in gaps in the existing data. The RI should be a field-oriented effort to gather additional data to identify whether airborne asbestos exists, to identify whether groundwater contamination exists, to support the evaluation of alternative source control and offsite remedial actions, and to support assessment of the potential effectiveness of these actions. The FS should develop and

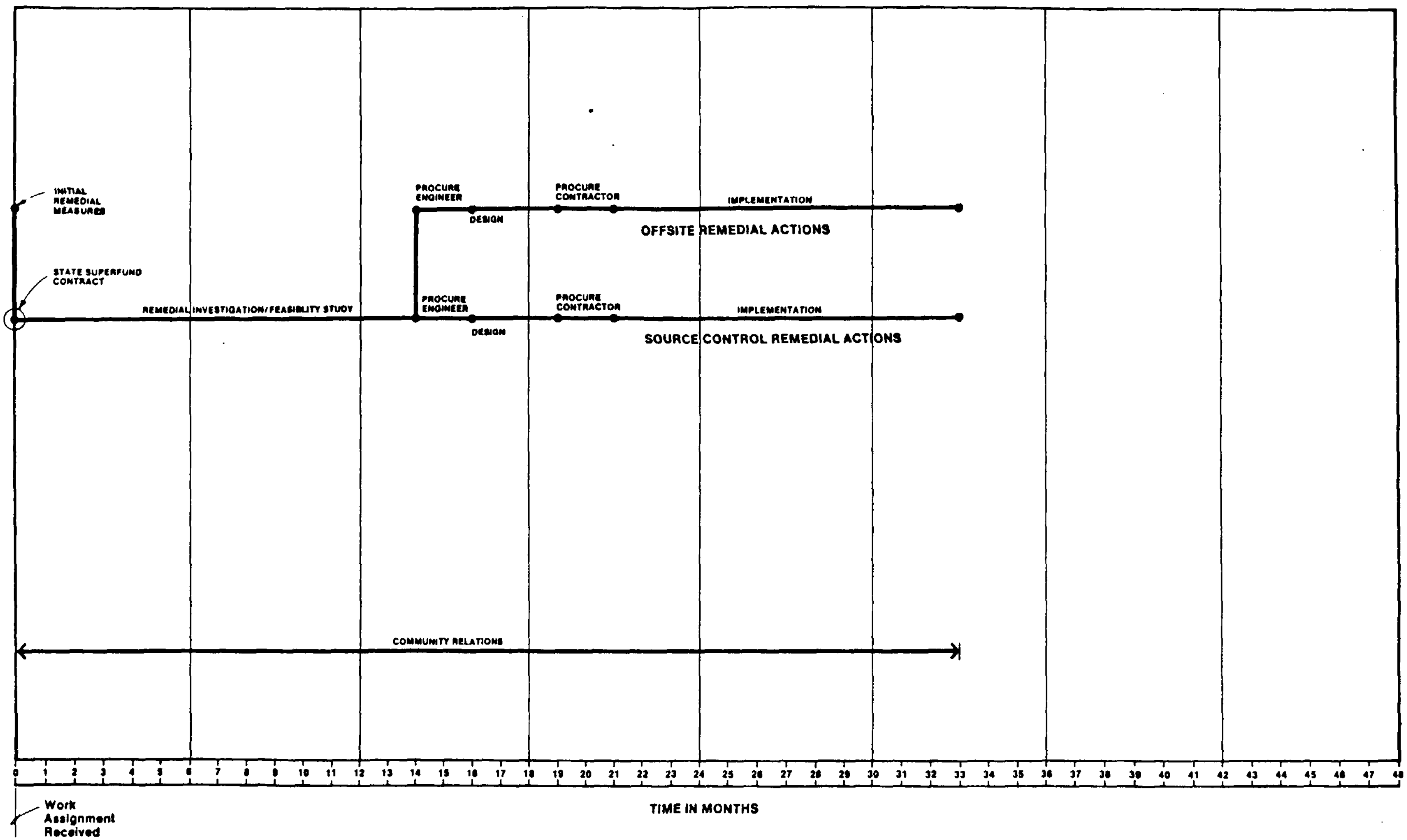
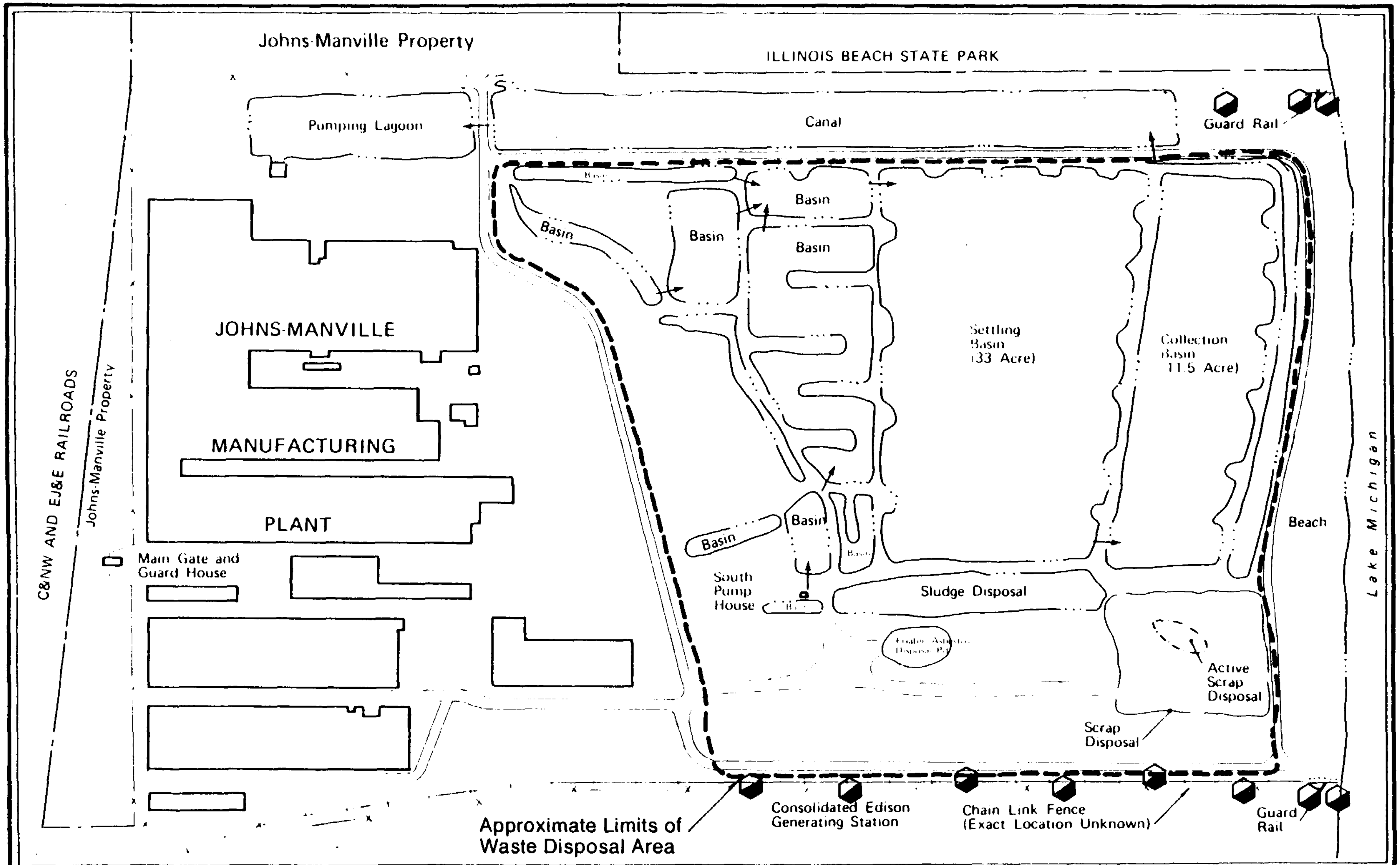


FIGURE 3-1
MASTER SITE SCHEDULE
Johns-Manville
Waukegan, Illinois
01-5VA5.0

W65005.00



0 250 500
SCALE IN FEET

Direction of Flow

Warning Sign

Note:
Some signs exist.
Supplement existing signs to provide 330 feet interval.

Figure 3-2
PROPOSED WARNING SIGN LOCATIONS
Johns-Manville
Waukegan, Illinois
01-5VA5.0

W65005.00

Table 3-1

PRELIMINARY COST ESTIMATE AND SCHEDULE OF
INITIAL REMEDIAL MEASURES
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Initial Remedial Measure	Estimated Cost Range Minimum	Maximum	Schedule (weeks) 1
Warning signs	1,100	1,600	-
	$ 1,100	$ 1,600	

evaluate the source control and offsite remedial action alternatives and prepare a conceptual design of the recommended alternative.

3.3.2 Scope of Work

The following sections describe the work plan to complete the RI/FS for the Johns-Manville site. Preliminary cost estimates and schedules are presented for each task. Discussions on the basis for each preliminary cost estimate are included with each task. Estimated costs for sample analysis assumed the use of non-contract labs and a 60-day turnaround period.

The RI/FS consists of the following tasks:

- Work plan preparation
- Site definition activities
- Detailed site characterization studies
- Site evaluation
- Remedial Investigation report
- Alternative remedial actions evaluation
- Feasibility Study
- Conceptual design
- Project management

3.3.2.1 Task 1: Work Plan Preparation

The objective of Task 1 is to refine the scope, cost, and schedule of the RI/FS generally discussed in this RAMP and to develop an implementation schedule and work plan. Task 1 includes preparing a work plan, visiting the site, assessing the site health and safety, preparing a quality assurance project plan, developing field protocols, preparing subcontractor procurement documents, and providing site safety and decontamination facilities.

Subtask 1-1: Work Plan Preparation. The objective of this subtask is to set detailed project objectives, tasks, and schedules for the RI/FS. The work assignment would be reviewed, and the technical disciplines necessary to complete the assignment would be determined. Team members, including USEPA and state staff, would attend a kickoff meeting with appropriate regulatory agency personnel. They would discuss overall project objectives and approach, discuss areas of sensitivity, establish communications and reporting channels, and coordinate the community relations program. It may be necessary to revise portions of the work scope proposed in this RAMP based on the results of the surface water sampling and analysis currently being conducted by IEPA (Document No. 036). Five copies of the draft work plan would be submitted to USEPA for review within 15 working days after the kickoff meeting. USEPA's review comments would be incorporated into the final work plan, and 10 copies submitted to USEPA for approval within 10 working days after receipt of the written comments.

For the purpose of providing a preliminary cost estimate, it is assumed that one meeting would be required at USEPA Region V in Chicago, Illinois. The following assumptions are also made:

- Airfare--one trip
- Per diem--two people, 2 days each
- Car rental--1 day
- Work plan of about 25 pages

Subtask 1-2: Initial Site Visit. The objectives of this subtask would be to become familiar with site topography, access routes, and proximity of receptors to possible contamination; and to collect data for preparation of the site health and safety plan, field protocols, and subcontractor procurement documents. Information from this site visit would also be essential for establishing boundary conditions to limit the area of investigation.

For the purpose of providing a preliminary cost estimate, it is assumed that one visit to Waukegan, Illinois, would be required. This visit would be made in conjunction with the meeting in Chicago for Subtask 1-1. The following assumptions were also made:

- Per diem--two people, 2 days each
- Car rental--1 day

Subtask 1-3: Site Health and Safety Plan. The objective of this subtask is to determine whether there are areas within the site that present potentially hazardous chemical exposure levels in air. The risks would be assessed in terms of the wastes disposed of at the site, the environmental fate and pathways of the wastes, the potential routes for human exposure (inhalation and ingestion), and the type of toxicological effects (acute, subacute, or chronic). In addition to protecting local residents and remedial investigators with adequate safeguards and warnings, the medical surveillance programs of all subcontractors would be reviewed to ensure compliance with the overall health and safety policies and procedures. A site health and safety plan would be prepared and five copies submitted to USEPA. The plan would be updated as needed to reflect unanticipated changes in the hazards or operating conditions encountered at the project area. The plan would be consistent with the work to be performed and would comply with:

- USEPA Occupational Health and Safety Manual
- USEPA Order 1440.1--Respiratory Protection
- USEPA Order 1440.3--Health and Safety Requirements for Employees Engaged in Field Activities
- USEPA Interim Standard Operating Safety Procedures and other USEPA guidance
- Illinois Occupational Safety and Health Act
- Site conditions

For the purpose of providing a preliminary cost estimate, it is assumed that the existing site health and safety plan could be used, with minor modifications.

<u>Subtask 1-4: Quality Assurance/Project Plan</u>. The objective of this subtask is to develop a quality assurance project plan (QAPP) plan for the sampling, analysis, and data-handling aspects of the RI tasks. The plan would be consistent with the requirements of the USEPA Contract Laboratory Program and the CH2M HILL Quality Assurance Guidance Document. The following points would be addressed:

- QA objectives and routine assessment of procedures for measurement data in terms of precision, accuracy, completeness, representativeness, and comparability
- QA performance and system audits, including frequency
- Calibration procedures and references, including frequency
- Internal QC checks and frequency
- Preventive maintenance procedures and schedules
- Sampling procedures

- Sample custody
- Corrective action
- Other needs specific to the work assignment, such as specialized sampling and analysis or data management needs that result from project requirements
- QA reports to management

Five copies of the quality assurance project plan would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that the QAPP would be about 10 pages.

Subtask 1-5: Field Protocols. The objective of this subtask is to develop field protocols for various situations that may occur during the work. The items that would be considered in this subtask include, but are not limited to:

- Decontamination methods for equipment
- Decontamination methods for sampling equipment between samples
- Hole abandonment procedures
- Disposal procedures for contaminated soils, groundwater, and air filters

Five copies of the technical memorandum on field protocols would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that the field protocols technical memorandum would be about 10 pages.

Subtask 1-6: Subcontractor Procurement. The objectives of this subtask are to prepare and submit contractor procurement documents, and to secure services of subcontractor(s) to conduct RI activities. This subtask includes:

- Prepare subcontractor procurement documents (specifications and bidding forms)
- Fulfill notice/advertising requirements
- Identify subcontractors and send out documents for bids

- Receive and evaluate bids

- Select subcontractor and submit selection to USEPA for approval

- Issue subcontract

Five copies of each subcontractor(s) procurement document would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that two contract documents, about 20 pages each would be required.

Subtask 1-7: Site Safety Facilities. The objective of this subtask is to identify and provide site safety and decontamination facilities for the RI/FS tasks. A combination decontamination and office trailer would be supplied for site use by all field personnel. In addition, personal air samplers would be worn by all field personnel to monitor airborne asbestos. Filters would be analyzed for asbestos fibers.

For the purpose of providing a preliminary cost estimate, it is assumed that the site health and safety assessment recommends Level C protection for all onsite activities. The preliminary cost estimate includes the use of disposable personal protective clothing and decontamination materials. It also includes the cost to analyze 96 filters for asbestos fibers.

3.3.2.2 Task 2: Site Definition Activities

The objective of Task 2 is to define the physical characteristics of the site through existing data and a new topographic survey. This task also includes the effort to gather and evaluate any remaining existing data on the site.

Subtask 2-1: Data Management. The objectives of this subtask are to collect and catalog existing data and information generated on the Johns-Manville site that may have been omitted or was not available during preparation of the RAMP, to develop a bibliography and key word cross reference to access the information easily, and to incorporate new data as they become available. Five copies of the data bibliography would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that one meeting at IEPA in Chicago, Illinois, would be required. A visit to Lake County offices, the Waukegan library, and other state agencies may also be required. The following assumptions are also made:

- Airfare--one trip

- Per diem--one person, 2 days
- Car rental--2 days
- Data bibliography of about 25 pages

Subtask 2-2: Topographic Survey. The objective of this subtask is to prepare a current site map showing elevations and locations of pertinent physical features, utilities, and facilities. The topographic survey of the site would tie horizontal distances of appropriate physical features and facilities to the property boundary, and vertical elevations to the National Geodetic Vertical Datum of 1929. A topographic map would be produced with 2-foot contours at a scale of 1 inch equals 100 feet. Typical features and facilities to be included are:

- Paved areas
- Above-grade structures
- Fences
- Vegetation
- Roads
- Basins
- Surface drainage
- Topographic contours
- Utilities, buried and above grade
- Location of buried structures

For the purpose of providing a preliminary cost estimate, it is assumed that about 300 acres would be surveyed, using aerial photography to develop the topographic map. The following assumptions are also made:

- Field crew consists of three technicians
- Level C protection is required by all personnel
- Subcontractor is required

3.3.2.3 Task 3: Detailed Site Characterization Studies

The objective of Task 3 is to obtain data to aid in the selection, screening, and evaluation of the remedial action alternatives. Task 3 includes soil sampling and analysis; groundwater monitoring well installation; groundwater quality sampling and analysis; additional groundwater monitoring well installation, sampling, and analysis; ambient air quality sampling and analysis review; and additional ambient air quality sampling and analysis. The scope of work proposed for Subtasks 3-1 through 3-6 should be reevaluated based on IEPA's forthcoming recommendations for RI activities.

Subtask 3-1: Soil Sampling and Analysis. The objective of this subtask is to determine whether the surface, near-surface, and subsurface soils are contaminated with hazardous substances. Johns-Manville has been dumping unknown wastes onsite since 1922. All onsite and offsite soils should be analyzed for inorganics and organics to determine the presence of unknown hazardous substances and should be analyzed for the presence of asbestos fibers. Representative surface and near-surface soil samples would be obtained with a solid-stem hand auger. Representative subsurface soil samples would be obtained during Subtask 3-2: Groundwater Monitoring Well Installation.

Six-inch samples would be taken at 0.0 to 0.5 foot and 1.0 to 1.5 feet typically at four places at each location. The samples will be composites from the locations at the two depth intervals. The proposed onsite and offsite sampling locations are shown on Figure 3-3. Sampling equipment would be decontaminated between samples. All sampling and testing would conform to guidelines in the User's Guide to the USEPA Contract Laboratory Program (CLP) prepared by the Sample Management Office of CLP and published in August 1982.

Soil samples would be analyzed for:

- Inorganic analysis package from USEPA CLP
- Organic analysis data package from USEPA CLP
- Asbestos fibers
- Thiram

A technical memorandum describing the soil sampling and analysis program would be prepared. The technical memorandum would include a description of the sampling procedure, a summary of the laboratory test results, and copies of the laboratory data sheets. Five copies of the technical memorandum would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, the following assumptions are made:

- Ten surface soil locations with composites of four places

- Twenty surface and near-surface soil samples analyzed for asbestos fibers, organic and inorganic packages, and thiram

- Six subsurface soil samples analyzed for asbestos fibers, organic and inorganic packages, and thiram

- Site sampling team consists of one engineering geologist/geotechnical engineer/hydrogeologist, and two technicians

- Level C protection is required by all personnel

- Cuttings can be disposed of onsite

- Technical memorandum of about 20 pages

- Per diem--3 people, 3 days each

- Car rental--3 days

Subtask 3-2: Groundwater Monitoring Well Installation. The objective of this subtask is to install groundwater monitoring wells. These wells would be used to determine whether the near surface groundwater is contaminated with hazardous substances. The proposed well locations are shown on Figure 3-4. The wells would be drilled through the sand and into the top of the till layer.

Screen positions would be determined in the field based on the subsurface conditions.

The monitoring wells would be constructed in compliance with Federal and state regulations. Well drilling and installation would be logged and inspected by a qualified hydrogeologist/geotechnical engineer/engineering geologist. General requirements are:

- All drilling equipment, pipe, and materials would be decontaminated before drilling.

- Eight-inch minimum diameter boreholes would be drilled with a hollow stem auger or cable tool drill rig.

- Continuous samples would be collected in the onsite hole using a standard split-spoon sampler (ASTM D 1586) until natural ground is reached.

- Wells would be constructed with 4-inch-diameter PVC casing. Well screens would be slotted PVC with threaded couplings, 10 feet in length. The

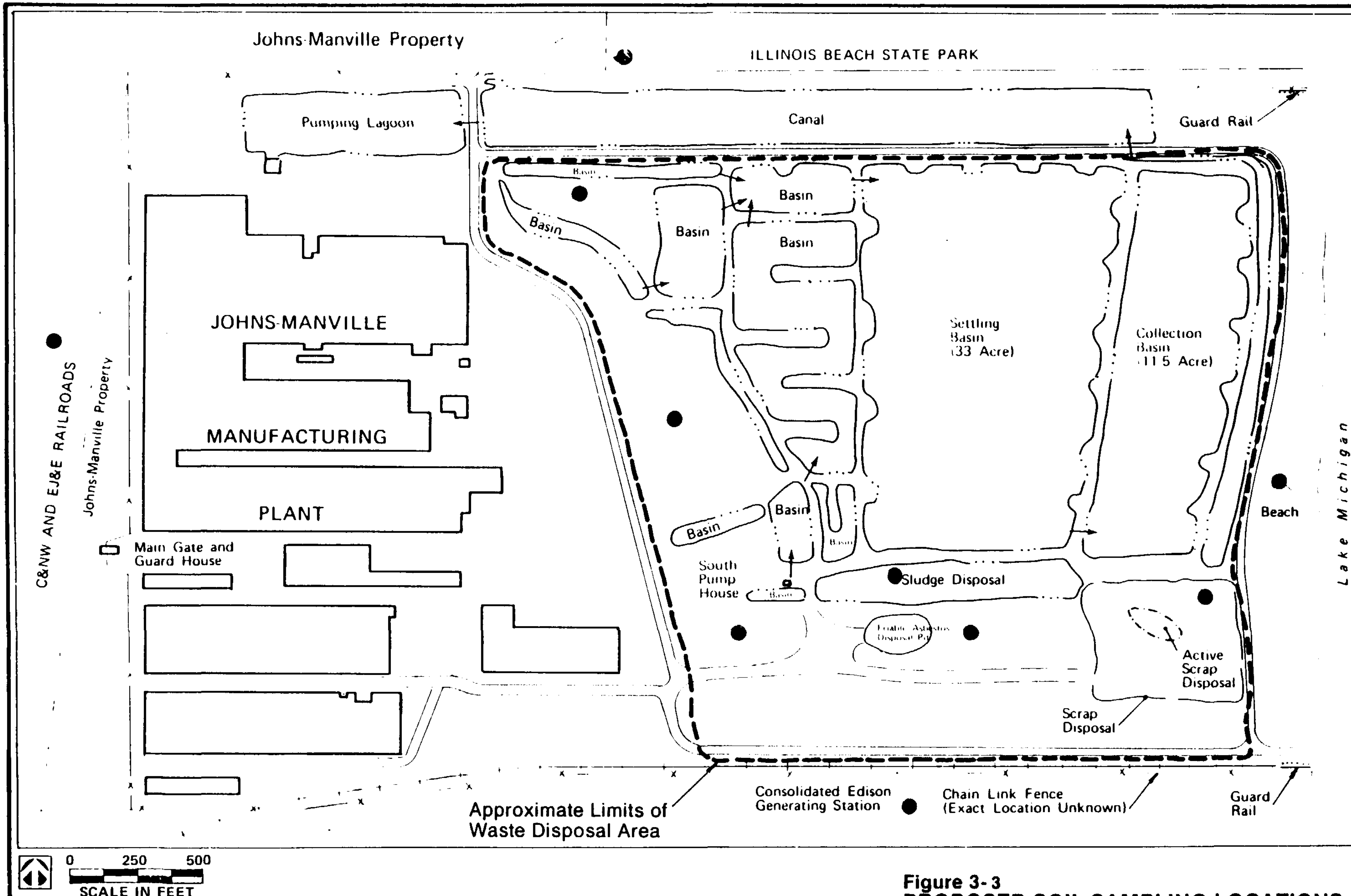


Figure 3-3
PROPOSED SOIL SAMPLING LOCATIONS
Johns-Manville
Waukegan, Illinois
01-5VA5.0

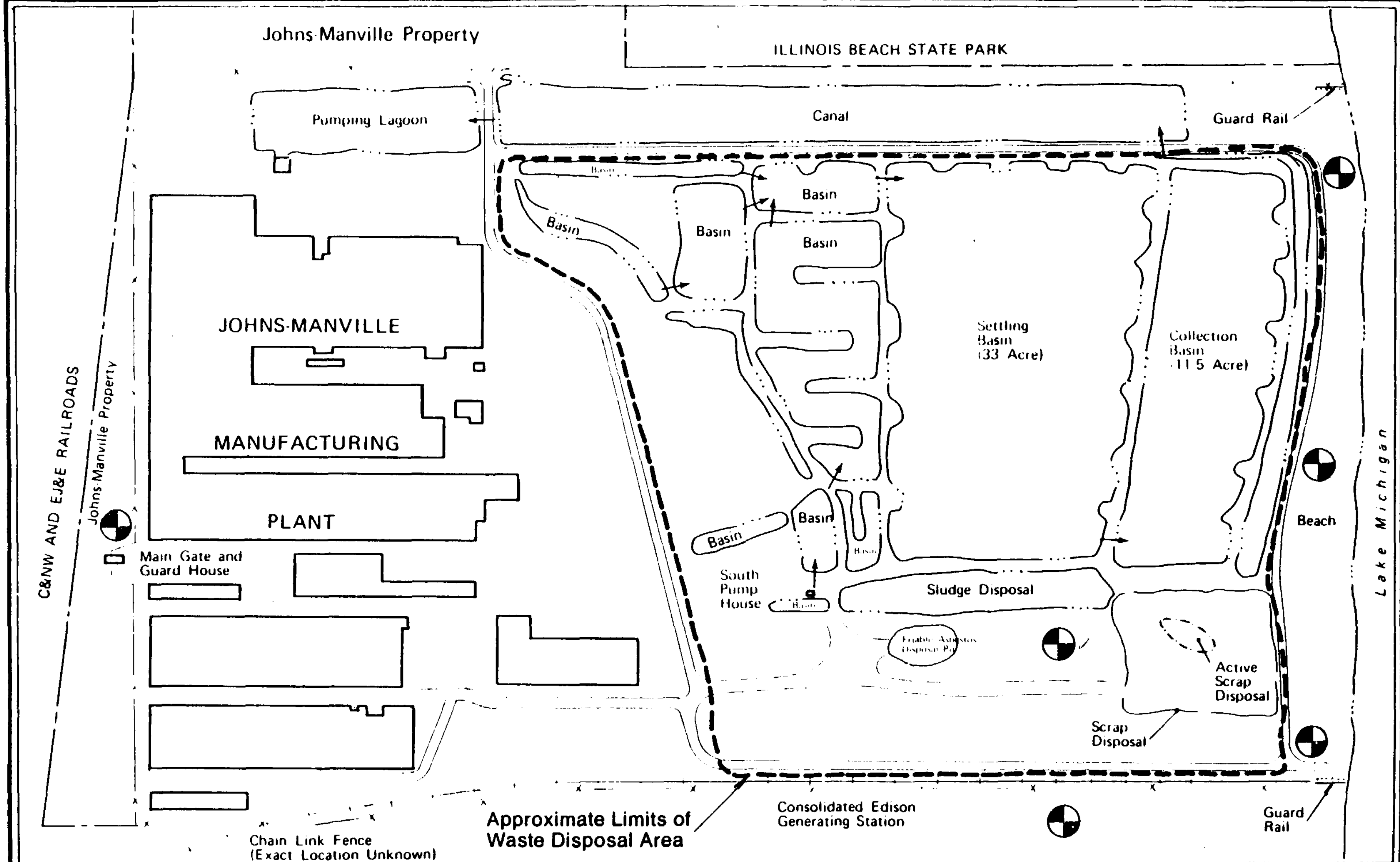


Figure 3-4
PROPOSED GROUNDWATER MONITORING WELL LOCATIONS
Johns-Manville
Waukegan, Illinois
01-5VA5.0

W65005.00

screened interval would be sand or gravel packed, and the annulus above the screen would be sealed with bentonite grout.

- A protective, vented, locking cap would be installed.
- Wells would be developed with air, bailing, or surging techniques after installation.
- All drilling equipment, pipe, and materials would be decontaminated before proceeding to the next hole.
- Top of casing elevations would be obtained for all wells to within 0.01 foot.
- Field hydraulic conductivity tests would be conducted on some wells if aquifer characteristics permit.

A technical memorandum describing the groundwater monitoring well installation would be prepared. The technical memorandum would include a description of the drilling and installation of wells and a summary of the field test results. Five copies of the technical memorandum would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, the following assumptions are made:

- Three hundred and fifty lineal feet of drilling and well installation at $50/foot
- Thirty lineal feet of continuous soil sampling
- Site drilling and sampling team consists of one engineering geologist/geotechnical engineer/hydrogeologist, and two technicians
- Level C protection is required for all personnel
- Subcontractor using two rigs is required for drilling
- Field hydraulic conductivity tests would be performed by site sampling team personnel
- All water used or discharged in the drilling process and all drill cuttings can be disposed of onsite
- Survey team consists of three technicians

- Technical memorandum of about 30 pages
- Airfare--two trips
- Per diem--3 people, 28 days each
- Car rental--28 days

Subtask 3-3: Groundwater Quality Sampling and Analysis. The objective of this subtask is to provide water quality data for determining whether the groundwater is contaminated with hazardous substances. Since Johns-Manville has dumped unknown wastes onsite since 1922, water quality samples should be analyzed for the inorganics and organics to determine the presence of unknown hazardous substances. Representative samples would be obtained from each new monitoring well. Sampling equipment would be decontaminated between samples. All sampling and testing would conform to guidelines in the User's Guide to the USEPA CLP prepared by the Sample Management Office of CLP and published in August 1982.

Groundwater samples would be analyzed for:

- Inorganic analysis package from USEPA CLP
- Organic analysis data package from USEPA CLP
- Thiram

A technical memorandum describing the groundwater sampling and analysis program would be prepared. The memorandum would recommend whether or not additional groundwater wells and sampling may be required based on the findings of this subtask. The technical memorandum would include a description of the sampling procedure, a summary of the laboratory test results, and copies of the laboratory data sheets. Five copies of the technical memorandum would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, the following assumptions are made:

- Six groundwater samples analyzed
- Site sampling team consists of one geotechnical engineer/engineering geologist/hydrogeologist, and two technicians
- Level C protection is required for all onsite personnel
- All water purged from the wells during the sampling can be disposed of onsite

- Technical memorandum of about 30 pages
- Per diem--3 people, 6 days each
- Car rental--6 days

Subtask 3-4: Additional Groundwater Monitoring Well Installation, Sampling, and Analysis. The objective of this subtask is to define the horizontal and vertical extent of the contamination identified in Subtask 3-3. This subtask would be performed only if hazardous substances other than chromium, lead, thiram, and xylene were identified in the groundwater quality samples. Subtask 3-4 would be performed with a change in the scope of work. Efforts needed, if any, would be identified in Subtask 3-3.

For the purpose of providing a preliminary cost estimate, it is assumed that Subtask 3-4 would not be required.

Subtask 3-5: Ambient Air Quality Sampling and Analysis Review. The objective of this subtask is to review ambient air quality data, obtained under separate contract, for asbestos fibers. Battelle Columbus Laboratories has been contracted by USEPA's Office of Toxic Substances (OTS) to evaluate existing data relative to air sampling and recommend further air quality monitoring.

Battelle has recommended collecting additional samples for 5 days at each of five locations onsite and at one background site. The samples would be analyzed by Transmission Electron Microscopy (TEM). We have assumed that Battelle will follow USEPA protocols. In addition, 12 quality assurance samples would be analyzed. Battelle estimated the costs to complete the work to be between $55,000 and $65,000. The schedule to complete the work is about 3.5 months. The results of Battelle's sampling and analysis program are included in Apopendix B. The resulting data would be reviewed along with the data from the personal air samplers (Subtask 1-7) to determine if additional sampling or analysis are required to complete the RI activities. A technical memorandum would be prepared to recommend whether or not additional air quality sampling and analysis is required based on the findings of this subtask. Five copies of the technical memorandum would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that a technical memorandum of about 10 pages would be required.

Subtask 3-6: Additional Air Quality Sampling and Analysis. The objective of this subtask is to provide additional data to the work performed by Battelle Columbus Laboratories.

This subtask would be performed only if the air quality sampling program is not adequate to complete the RI activities. Subtask 3-6 would be performed with a change in the scope of work. Efforts needed, if any, would be identified in Subtask 3-5.

For the purpose of providing a preliminary cost estimate, it is assumed that Subtask 3-6 would not be required.

3.3.2.4 Task 4: Site Evaluation

The objective of the site evaluation task is to determine whether or not the materials at the Johns-Manville site present a hazard to human health or welfare, or to the environment. Existing standards would be reviewed to formulate conclusions and recommendations regarding the hazard potential of the site. A draft technical memorandum would be prepared summarizing the hazard evaluation process and presenting the results of the hazard assessment. Five copies of this draft technical memorandum would be submitted to USEPA for review, and a review meeting would be held with USEPA and the State to discuss it. USEPA's review comments would be incorporated into the final technical memorandum, and 25 copies would be submitted to USEPA for approval within 10 working days after receipt of written comments.

For the purpose of providing a preliminary cost estimate, the following assumptions are made:

- One review meeting held at USEPA Region V in Chicago, Illinois
- Airfare--one trip
- Per diem--one person, 2 days
- Car rental--2 days
- Technical memorandum of about 50 pages

3.3.2.5 Task 5: Remedial Investigation Report

The objective of the RI report is to consolidate and summarize the data obtained and documented in previously prepared technical memoranda during Tasks 1 through 4. The draft RI report would also include a discussion of the remedial actions considered, recommendations regarding whether or not to proceed with the evaluation of remedial action alternatives, and the recommended remedial action alternatives that should be included in the evaluation.

Before preparing the draft RI report, a review meeting would be held with USEPA and the State to determine remedial action objectives, to identify potential or existing contaminant releases and associated remedial actions to be addressed in the FS, and to discuss the contents of the RI report. A list of potential and existing contaminant releases and potential remedial actions would be prepared by the project team to provide a basis for the discussion.

To determine the practicality of various alternative source control and offsite control remedial actions, the following factors would be qualitatively evaluated based on how they meet the project objectives:

- Ability to control onsite release or to reduce undesirable effects offsite (high, medium, low)
- Adverse environmental effects (high, medium, low)
- Feasibility, applicability, and reliability of remedial actions for the specific location and conditions of release (yes, no, potential)
- Preliminary cost estimate indicator (high, low, medium) for both capital and operation and maintenance costs

On the basis of the review meeting, an agreement would be reached on the remedial action alternatives to be evaluated.

Ten copies of the draft RI report would be submitted to USEPA within 15 working days after the review meeting. USEPA's review comments would be considered in preparation of the final report, and 40 copies would be submitted to USEPA for approval within 10 working days after receipt of the written comments.

For the purpose of providing a preliminary cost estimate, it is assumed that two meetings would be required at USEPA Region V in Chicago, Illinois. The following assumptions are also made:

- Airfare--two trips
- Per diem--two people, 4 days each
- Car rental--4 days
- RI report of about 100 pages

3.3.2.6 Task 6: Alternative Remedial Actions Evaluation

The objectives of the alternative remedial actions evaluation task are to evaluate alternative remedial actions on the basis of economic, environmental, and engineering criteria and to select an alternative or combination of alternatives for conceptual design and implementation. The level of detail used in these evaluations identifies only comparative or relative differences among alternatives.

Subtask 6-1: Description of Proposed Response. The objective of this subtask is to summarize the site background information and the nature and extent of the problem. In consultation with USEPA, the site-specific objectives, screening criteria, and proposed response would be developed. The scope of work for the FS would be revised based on the results of the RI. Five copies of the proposed response technical memorandum would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that the technical memorandum would be about 10 pages.

Subtask 6-2: Development of Alternatives. The objective of this subtask is to compile a list of potential source control and offsite remedial action alternatives. The alternatives would be based on site-specific objectives and public health and environmental concerns. The alternatives would incorporate appropriate remedial technologies identified in the RI report. Five copies of the development of alternatives technical memorandum would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that the technical memorandum would be about 25 pages.

Subtask 6-3: Initial Screening of Alternatives. The objective of this subtask is to evaluate alternative remedial actions based on cost, effects of alternative, and acceptable engineering practices. Alternatives that far exceed the costs of other alternatives evaluated and do not provide substantially greater public health or environmental benefit would be excluded from further consideration. Only those alternatives that effectively contribute to the protection of public health, welfare, or the environment would be considered further. Alternatives must also be considered feasible, be applicable to the problem, and represent a reliable means of addressing the problem. Five copies of the initial screening of alternatives technical memorandum would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that the technical memorandum would be about 20 pages.

Subtask 6-4: Detailed Analysis of Alternatives. The objective of this subtask is to develop engineering details on the remaining alternatives and Order-of-Magnitude cost estimates. These engineering details would include alternative descriptions and conceptual site layout drawings, operation and maintenance requirements, safety requirements, and special engineering considerations. Another objective would be to assess each alternative in terms of the extent to which it is expected to effectively mitigate and minimize damage to, and provide adequate protection of, public health, welfare, and the environment, relative to the other alternatives analyzed.

Five copies of the detailed analysis of alternatives technical memorandum would be submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that the technical memorandum would be about 100 pages.

3.3.2.7 Task 7: Feasibility Study Report

The objective of the FS report is to compile and describe the methods, results, and conclusions of the alternative remedial actions evaluation task. The report would identify the cost-effective alternative. Ten copies of the draft FS report would be submitted to USEPA for review, and a review meeting would be held to discuss it. Within 10 working days of receipt of review comments, a final report would be prepared and 40 copies submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that one meeting would be required at USEPA Region V in Chicago, Illinois. The following assumptions are also made:

- Airfare--one trip
- Per diem--one person, 1 day
- Car rental--1 day
- Feasibility Study report of about 200 pages

3.3.2.8 Task 8: Conceptual Design

The objective of the conceptual design task is to define the selected remedial action alternative for the design and implementation phases. The conceptual design would include an implementation schedule, phasing considerations, preliminary design criteria, preliminary site and facility layouts, operation and maintenance requirements, an outline of the health and safety plan, and a refined cost estimate. It is recommended, if possible, that the lead agency be included in reviews of work plans and work products during conceptual design activities. Ten copies of a draft conceptual design report would be submitted to USEPA for review, and a review meeting would be held to discuss it. Within 10 working days of receipt of review comments, a final report would be prepared and 40 copies submitted to USEPA.

For the purpose of providing a preliminary cost estimate, it is assumed that one meeting would be required at USEPA Region V in Chicago, Illinois. The following assumptions are also made:

- Airfare--one trip
- Per diem--one person, 1 day
- Car rental--1 day
- Conceptual design report of about 50 pages

3.3.2.9 Task 9: Project Management

The objective of the project management task is to establish project records; prepare monthly reports; monitor RI/FS staffing, budgets, and subcontractor performance; and maintain quality assurance programs.

For the purpose of providing a preliminary cost estimate, it is assumed that this task would be about 10 percent of the total estimated RI/FS budget.

3.3.3 Remedial Investigation/Feasibility Study Estimated Costs/Time Schedule/Deliverables

Table 3-2 presents the preliminary costs for the Johns-Manville site RI/FS tasks. A preliminary schedule for the RI/FS activities is presented in Figure 3-5.

The following deliverables would be provided for the tasks outlined in the RI/FS scope of work:

RI/FS Task	Deliverables
Task 1	Draft work plan
	Final work plan
	Site health and safety plan (SH&SP)
	Quality assurance project plan (QAPP)
	Field protocols technical memorandum

Table 3-2

ESTIMATED COSTS FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Task	Minimum Cost			Maximum Cost			Estimated Cost Range	
	Engineering	Expenses	Subcontract	Engineering	Expenses	Subcontract	Minimum	Maximum
1-0 Work Plan Preparation								
1-1 Work plan preparation	$ 6,900	$ 1,700	0	$ 10,400	$ 2,600	0	$ 8,600	$ 13,000
1-2 Initial site visit	2,800	400	0	4,200	600	0	3,200	4,800
1-3 Site health and safety plan	1,200	100	0	1,800	200	0	1,300	2,000
1-4 Quality assurance/quality control	2,600	100	0	3,900	200	0	2,700	4,100
1-5 Field protocols	2,700	100	0	4,000	200	0	2,800	4,200
1-6 Subcontractor procurement	5,500	300	0	8,200	400	0	5,800	8,600
1-7 Site safety facilities	1,600	4,500	$ 3,400	2,400	6,800	$ 5,100	9,500	14,300
Subtotal	23,300	7,200	3,400	34,900	11,000	5,100	33,900	51,000
2-0 Site Definition Activities								
2-1 Data management	2,700	1,100	0	4,000	1,600	0	3,800	5,600
2-2 Topographic survey	800	100	21,000	1,200	200	31,500	21,900	32,900
Subtotal	3,500	1,200	21,000	5,200	1,800	31,500	25,700	38,500
3-0 Detailed Site Characterization Studies								
3-1 Soil sampling and analysis	5,200	1,100	20,900[a]	7,800	1,600	31,400[a]	27,200	40,800
3-2 Groundwater monitoring well installation	29,400	9,800	21,200	44,100	14,700	31,800	60,400	90,600
3-3 Groundwater quality sampling and analysis	7,200	1,600	5,100[a]	10,800	2,400	7,600[a]	13,900	20,800
3-4 Additional groundwater monitoring well installation, sampling, and analysis	NI[b]	NI	NI	NI	NI	NI	NI	NI
3-5 Ambient air quality sampling and analysis review	5,600	600	55,000[c]	8,400	900	65,000[c]	61,200	74,300
3-6 Additional air quality sampling and analysis	NI	NI	NI	NI	NI	NI	NI	NI
Subtotal	47,400	13,100	102,200	71,100	19,600	135,800	162,700	226,500

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Table 3-2 (continued)

ESTIMATED COSTS FOR REMEDIAL INVESTIGATION/FEASIBILITY STUDY
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Task	Minimum Cost			Maximum Cost			Estimated Cost Range	
	Engineering	Expenses	Subcontract	Engineering	Expenses	Subcontract	Minimum	Maximum
4-0 Site Evaluation	$ 21,300	$ 1,600	0	$ 32,000	$ 2,400	0	$ 22,900	$ 34,400
5-0 Remedial Investigation Report	18,300	3,000	0	27,400	4,500	0	21,300	31,900
6-0 Alternative Remedial Action Evaluation	32,400	3,200	0	48,600	4,800	0	35,600	53,400
7-0 Feasibility Study Report	9,900	2,400	0	14,800	3,600	0	12,300	18,400
8-0 Conceptual Design	13,600	1,600	0	20,400	2,400	0	15,200	22,800
9-0 Project Management	17,000	3,300	0	25,400	5,000	0	20,300	30,400
Total	$186,700	$36,600	$126,600	$279,800	$55,100	$172,400	$349,900	$507,300

[a]Non-contract laboratory.
[b]NI = Not included in cost estimate. Costs would be added by change order if needed.
[c]Estimated cost furnished by Battelle Columbus Laboratories to USEPA OTS; included for reference.

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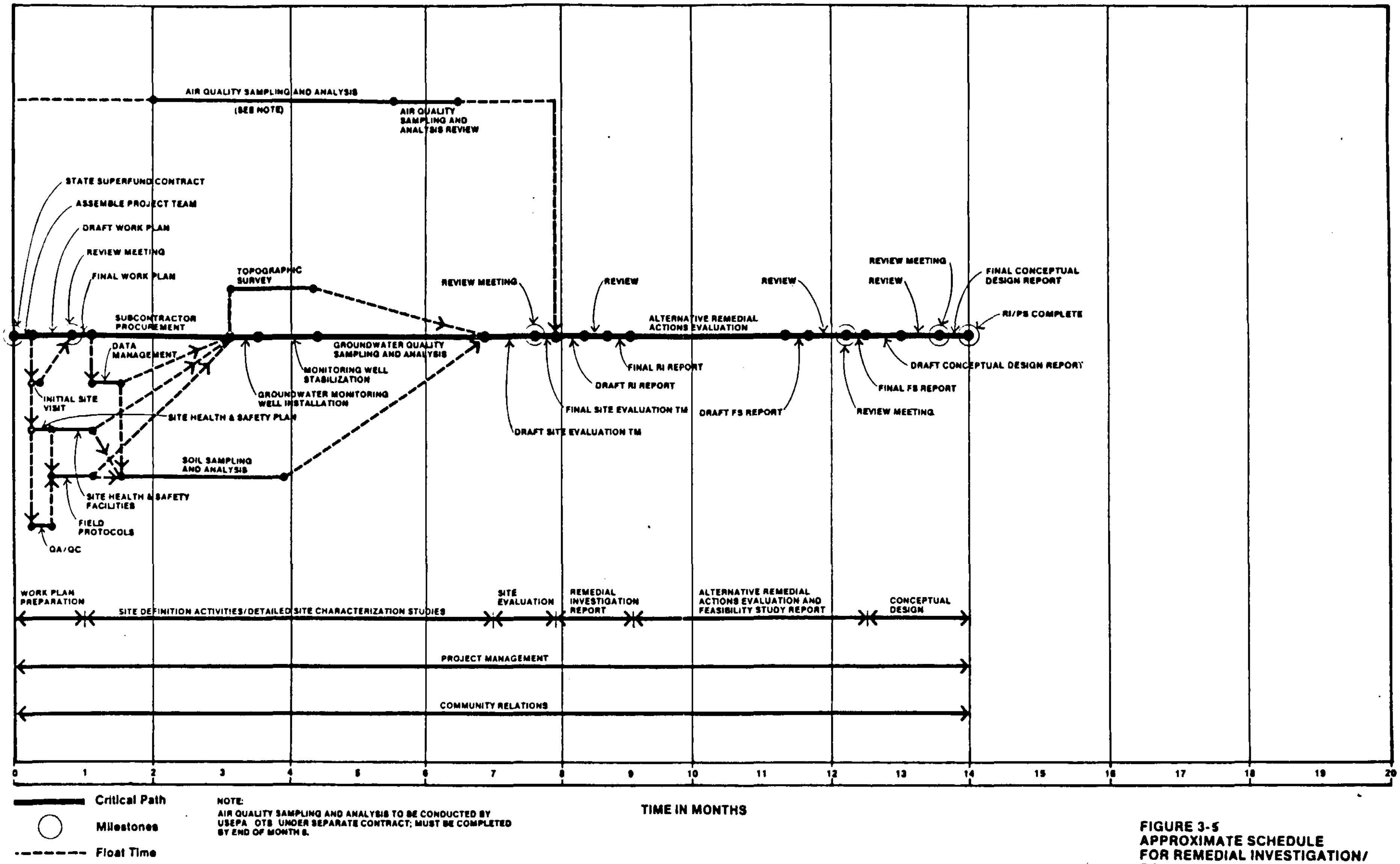

FIGURE 3-5
APPROXIMATE SCHEDULE FOR REMEDIAL INVESTIGATION/ FEASIBILITY STUDY
Johns-Manville
Waukegan, Illinois
01-5VA5.0

W65005.00

RI/FS Task	Deliverables
	Subcontractor(s) procurement documents
Task 2	Data bibliography
	Topographic map
Task 3	Soil sampling and analysis technical memorandum
	Monitoring well installation technical memorandum
	Groundwater quality sampling and analysis technical memorandum
	Air quality sampling and analysis review technical memorandum
Task 4	Draft site hazard assessment technical memorandum
	Final site hazard assessment technical memorandum
Task 5	Draft RI report
	Final RI report
Task 6	Proposed response technical memorandum
	Development of alternatives technical memorandum
	Initial screening of alternatives technical memorandum
	Detailed analysis of alternatives technical memorandum
Task 7	Draft FS report
	Final FS report
Task 8	Draft conceptual design report
	Final conceptual design report
Task 9	Project management reports and records

3.4 SOURCE CONTROL REMEDIAL ACTIONS

3.4.1 Objective

Source control remedial actions include measures to prevent, reduce, or eliminate contamination by either containing the hazardous wastes in place or removing them from the site. Appropriate actions can be formulated only after sufficient data have been generated through the RI/FS activities to determine the extent and nature of the contamination, determine whether a significant public health hazard or environmental problem exists at the site after completion of IRMs, and develop an appropriate site and vicinity model. Source control remedial actions may not be appropriate if most hazardous substances have already migrated off the site or are adequately contained.

3.4.2 Remedial Action Alternatives

Alternative source control remedial actions that may be appropriate for the Johns-Manville site are:

- No action (may apply to all or part of the actions)
- Extensive monitoring of the site, with no immediate removal or containment activities
- Encapsulation of contaminated soils and/or groundwater with an impermeable barrier

3.4.3 Order-of-Magnitude Level Costs/Schedule

Sufficient data are not available to estimate the cost of suggested source control remedial action alternatives. The costs could be very low if it is found that there is no current source causing the contamination, or if there is no current migration from the source. If there must be containment and encapsulation of both surface soils and groundwater, the costs could be high.

3.5 OFFSITE REMEDIAL ACTIONS

3.5.1 Objective

Offsite remedial actions include measures to mitigate the effects of the hazardous waste contamination that may have migrated beyond the site. Appropriate actions can be formulated and analyzed only after sufficient data have been generated through the RI/FS to determine the extent and nature of the offsite contamination and to determine whether a significant public health hazard or environmental problem exists offsite. Depending on the results of the RI, offsite remedial actions may or may not be required.

3.5.2 Remedial Action Alternatives

Depending on the results of the RI/FS, the following offsite remedial actions may be appropriate for the Johns-Manville site:

- No action (may apply to all or part of the actions)
- Removal of contaminated soil and disposal in an approved hazardous waste landfill

3.5.3 Order-of-Magnitude Level Costs/Schedule

Sufficient data are not available to estimate the cost of suggested offsite remedial action alternatives.

Section 4
COMMUNITY RELATIONS ASSESSMENT

This community relations assessment outlines suggested actions to be taken during the RI/FS for the Johns-Manville site. The selection of appropriate objectives and techniques was based on the site history, past community relations activities, interested participants, and issues relating to the site. A final community relations plan would include specific work tasks, staff allocation, and budget. It would be implemented by USEPA Region V.

Information for this assessment was obtained from discussions with the persons listed in Table 4-1.

4.1 COMMUNITY RELATIONS BACKGROUND

4.1.1 Site History

The Johns-Manville site is located on the shoreline of Lake Michigan, in northern Waukegan, Illinois. The waste disposal site at the manufacturing plant has been used for friable and non-friable asbestos waste disposal from about 1922 to the present. The major plant operations that used asbestos have been discontinued.

Air sampling was conducted at the facility in 1973 and 1982. Based on the results of these tests and other site evaluations, the site was listed on the National Priority List in 1982. Johns-Manville contested its placement on the list. Both USEPA and IEPA are currently conducting additional tests on the site that will further define the nature and severity of air, soil, and water quality problems. No enforcement actions are pending at this time.

4.1.2 History of Community Relations Activities

There has been no local media coverage of the site itself. The site was mentioned in a local newspaper article about the Superfund National Priority List, and there has been some local as well as Chicago media coverage in recent months about the Johns-Manville Company. This has primarily focused on the failure of the company to release medical records of employees, on working conditions at the site, and on the company filing for bankruptcy.

Public interest and involvement have also been minimal. No inquiries concerning the site have been made to the City of Waukegan or the Lake County Health Department. This apparent lack of public interest is probably related in part to the recent media and citizen concentration on the Outboard

Table 4-1

PERSONS CONTACTED FOR COMMUNITY RELATIONS ASSESSMENT
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

City of Waukegan (312-689-7500)

Roger Harrison, Environmental Protection Director
Bob O'Neil, Planner/Engineer

Illinois Environmental Protection Agency

Charles Gruntman, Division of Land Pollution Control (Maywood) (312-345-9780)

Brad Benning, Division of Land Pollution Control (Maywood)

Sudhir Desai, Division of Air Pollution Control (Maywood)

Cy Levine, Division of Air Pollution Control (Maywood)

Mark Haney, IEPA Project Manager (Springfield) (217-782-6760)

Lake County Health Department

Jim Ambroso, Solid Waste Specialist (312-689-6747)

Lake County Defenders

Sue Pitman (312-234-5147)
Anne Shannon

Lake Michigan Federation

Judy Kiriazis, Executive Director (312-427-5121)

League of Women Voters (312-234-6826)

Carolyn Sevchik, Lake County League
Sara Clark, Lake County League
Di Kiekhefer, Barrington League

Michigan Charter Boat Association

Mike Berkson, President (312-367-6332)

Waukegan Port District

Bruce Lawson, Deputy Director (312-244-0055)

Marine Corporation (OMC) site in Waukegan harbor. The OMC site has had extensive publicity and has generated a high level of public interest.

4.1.3 Community Relations Issues and Participants

The level of public interest in the Johns-Manville site appears to be very low. The City of Waukegan, the Lake County Health Department, and a county environmental organization (Lake County Defenders) have expressed interest in the site. There was a general consensus among those interviewed that the "affected community" would extend along the lakefront from Lake Bluff to Zion. It was generally felt that residents of other North Shore communities, Chicago and rural Lake County would not have a great deal of interest in site-related activities.

The city's master plan indicates an open space corridor along the lakefront that includes the Johns-Manville site. According to the city staff interviewed, the city's long-range goal is to use the site for public recreation. Johns-Manville representatives have recently discussed that possibility with city officials.

The city's major concern is the air quality in the immediate vicinity of the site. The site is located about one-half mile north of heavily used recreational beaches, is adjacent to a fishing pier (located at the Commonwealth Edison warm-water outflow), and is east of a large city park and the Buckley Hills neighborhood. From 500 to 1,000 persons reside in this area. It is a neighborhood of generally well-educated, affluent people. No community action groups have formed concerning the site.

City staff also expressed concern about the possibility of contamination of drinking and swimming water. The municipal water system intake is in Lake Michigan about 1 mile from the site. City staff feel that the OMC site history has somewhat lessened the credibility of the USEPA in the area, but believe that this is likely to improve as the harbor cleanup progresses. There has been some tension between the city and IEPA over the last few years related to IEPA's legal actions against the city. These have resulted in the cleanup of four landfill sites at city expense.

The Lake County Health Department has an active interest in the cleanup of hazardous waste sites. The solid waste specialist, Jim Ambroso, indicated that the department does not yet have a good understanding of the severity of the problems associated with the Johns-Manville site, but wants to be kept informed. He believes that concerned citizens are likely to call the Health Department for information and wants to ensure that city staff can accurately answer their questions. Mr. Ambroso also feels it is unlikely that the

24-member County Board will become actively involved in site cleanup-related activities, but suggested that several members of the Board will follow the events with interest.

The Lake County Defenders is a 6-month-old, countywide, non-profit environmental group that has about 65 members. It has become active on several issues including pesticide spraying, cleanup of the OMC site, and recycling. The organization has adopted general policies on the disposal of toxic and hazardous wastes and has some specific concerns about the Johns-Manville site. Group spokespersons indicated the need to: (1) educate the general public on the Superfund program; (2) publish schedules for public participation in the process well in advance; and (3) schedule comment periods at times when the public is generally available to participate (for example, not during holiday and vacation weeks). In relation to the RI, the group's representatives think it is important to test the air quality at offsite locations to determine the severity of the asbestos contamination in the vicinity. The group believes it is critical to pursue cleanup alternatives and to use construction methods that do not increase the risk of community exposure to asbestos (such as moving it offsite). They feel that site cleanup will require careful consideration of climatological factors and specific training of onsite personnel.

Seven League of Women Voters organizations are located in the general area, comprising a total of about 700 members. Six are local League groups and one is a countywide League. Hazardous waste disposal is not a focus of any of these groups, although the Lake County League conducted an in-depth solid waste study in 1981 that highlighted the need for consideration of future solid waste disposal alternatives. They sponsored a series of public educational meetings in conjunction with the study and included an explanation of both the Superfund legislation and hazardous waste regulations. Various League representatives expressed a need for public education concerning the Superfund program, as well as several specific concerns about the Johns-Manville site. Their specific concerns included disposal of the asbestos wastes at the site rather than moving them through the community, and the importance of making Johns-Manville financially responsible for site cleanup.

The Lake Michigan Federation is an environmental protection organization that has worked with USEPA for a number of years on a variety of issues. They have recently been active in activities concerning the OMC site in Waukegan. The group's executive director does not think the Johns-Manville site is a threat to the Lake Michigan environment and, for that reason, expects that the Federation will not follow events at the site closely. This attitude is shared by two other organizations that have become deeply involved in the OMC site activities: the Waukegan Charter Boat Association and the Waukegan Port District.

Although public awareness of the site seems to be very low, it is likely to increase as a result of Superfund activities. The extent to which public interest is generated will relate especially to a shift in media coverage from the OMC site to the Johns-Manville site or to the identification of significant offsite air quality problems. A concerted public information program does not appear necessary at this time, but one should be organized and readied for implementation should public concern about the site significantly increase.

4.2 COMMUNITY RELATIONS OBJECTIVES AND TECHNIQUES

4.2.1 Community Relations Objectives

1. Establish coordination among the USEPA project teams associated with the Wauconda Sand and Gravel, OMC, and Johns-Manville sites to ensure that community relations activities complement each other and are responsive to overlapping but separate groups of citizens, agencies, organizations, and elected officials.

2. Establish open, two-way communication between local residents, agencies, organizations, and elected officials, and the USEPA remedial action team.

3. Establish an effective means of sharing technical information among participating interest groups, agencies, and officials including the IEPA, City of Waukegan, Lake County Health Department, Lake County Board, Libertyville and Waukegan Townships, and Lake County Defenders.

4. Inform interested citizens, agencies, organizations, elected officials, and the media of the timing and purpose of major activities at the site (see Table 4.2 for a list of contacts).

5. Provide interested citizens, agencies, organizations, elected officials, and the media with information on the scope, progress, and findings of the RI/FS.

6. Provide an opportunity for public comment on the remedial action alternatives identified in the FS prior to selection of the final remedial actions.

7. Identify environmental, public interest, or other groups that may become interested in the site as work progresses. Provide interested parties with information about the study, as appropriate.

Table 4-2

PRELIMINARY MAILING LIST
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

News-Sun
100 Madison Street
Waukegan, IL

WKZN-AM Radio
2700 Sheridan Road
Zion Lake Bluff, IL 60044

WKRS-AM Radio
3250 Belvidere
Waukegan, IL

WXLC-FM Radio
3250 Belvidere
Waukegan, IL

U.S. Cable TV of Lake County
3233 Grand Avenue
Waukegan, IL

Chicago Tribune
Suburban Edition

Chicago Sun-Times
Suburban Supplement

Ellen Maynard
Zion Environmental
Concerns Commission
2209 Ennaus
Zion, IL

Lake Bluff League of
Women Voters
c/o Maureen Ferg
P.O. Box 74
Lake Bluff, IL 60044

Deerfield League of
Women Voters
P.O. Box 124
Deerfield, IL 60015

Lake County Defenders
c/o Sue Pitman
520 Forest Grove
Lake Bluff, IL

Paulette Lyons
1110 North
Waukegan, IL

Mike Graham
Libertyville Township Office
359 Merrill Court
Libertyville, IL 60048

John Balen
942 South McAree
Waukegan, IL 60085

Barrington League of
Women Voters
c/o Elaine Lalonte
45 Meadow Lane
Barrington, IL 60010

Libertyville/Mundelein
League of Women Voters
c/o Joanne Eckmann
1239 Deer Trail Lane
Libertyville, IL 60040

Waukegan/Zion League of
Women Voters
c/o Susan Wysocki
2116 Devonshire
Waukegan, IL 60087

Glen Miller, Chairman
County Board
County Courthouse
Waukegan, IL

Bill Morris, Mayor
City Hall
Waukegan, IL

Table 4-2 (continued)

PRELIMINARY MAILING LIST
JOHNS-MANVILLE
WAUKEGAN, ILLINOIS
01-5VA5.0

Lake Forest League of
Women Voters
Gorton Community Center
400 E. Illinois Road
Lake Forest, IL

Lake County League of
Women Voters
c/o Carolyn Sevchik
714 Washington Street
Lake Bluff, IL 60044

Milton Staben, Supervisor
Waukegan Township
South Genesee and Lake Street
Waukegan, IL

Roger Harrison
Community Development and
Enforcement
City of Waukegan
Waukegan, IL 60085

Jim Ambroso
Lake County Health Department
3010 Grand Avenue
Waukegan, IL 60085

John Matijevich
State Representative
226 North Utica
Waukegan, IL 60085

8. Monitor public concerns and information needs throughout the study. Modify the community relations plan as necessary to respond to changes in community attitudes and needs.

4.2.2 Community Relations Techniques

1. Central Information Repository. A repository for technical reports, fact sheets, and other written materials pertaining to the study should be established at the Waukegan Public Library.

2. Mailing List. A mailing list of citizens, elected officials, organizations, and agencies interested in the study should be developed and updated throughout the study.

3. News Releases. Given the current level of public interest at this site, the media is the most effective means of providing information to the general public. News releases should be issued at appropriate times throughout the RI/FS, including the following:

   - At the beginning of the study to provide general background on the Superfund program and to describe the purpose, activities, and schedule of the study. This release should be accompanied by a fact sheet.

   - At the completion of the RI, or whenever significant study or test results are available.

   - Two weeks before the release of the FS for public comment to identify local information contacts, the location of the information repository, the procedure for making comments, the schedule of public meetings (if any are to be held), and so on.

   - At the completion of the FS, to announce the recommended alternative. This release should be accompanied by a fact sheet.

   News releases should be distributed to all persons on the mailing list. They should also be filed in the central information repository.

4. Fact Sheets. Fact sheets should be prepared to provide more detailed information than can be included in the press releases. They should be prepared at the outset of the RI to provide an overview of the project and at the end of the study to summarize findings and recommendations. Other fact sheets should be prepared as necessary to meet local information needs. Fact sheets

should be distributed to all persons on the mailing list and should be filed in the central information repository.

5. <u>Periodic Briefings</u>. Libertyville and Waukegan Township, Lake County, state, and Federal elected officials should be contacted at the beginning of the study to determine their information needs. Briefings should be provided as appropriate throughout the study. These could be in the form of news releases, fact sheets, telephone calls, or meetings. Key local agency officials, including representatives from the staffs of the City of Waukegan and the Lake County Health Department, could also be included in these briefings, if appropriate.

6. <u>Technical Summaries</u>. In order for residents and local officials to respond usefully to proposed alternatives, they must be able to understand the technical information. This understanding must be built through the RI/FS process. Technical summaries of the RI report and FS would be prepared for distribution to local officials and the interested public. These summaries would present the technical information in a way that can be understood and evaluated by the general public. They would be clear, accurate descriptions of study results, prepared in a style and format that encourage public use and understanding.

7. <u>Public Meetings</u>. The need for public meetings should be evaluated throughout the remedial activities. Although little public interest is now evident, activities at the site or findings of the RI/FS could raise concerns and questions that might best be addressed at meetings.

   A small neighborhood meeting in Buckley Hills or elsewhere in the immediate vicinity of the site might be useful at the outset of the RI if offsite testing or other investigative activities are likely to generate concern among residents, or during the RI if air quality problems are identified.

   Areawide public meeting(s) to review alternatives and receive public comment at the completion of the FS might also be appropriate. The experience with areawide public meetings in the OMC project should provide insight into their usefulness in relation to the Johns-Manville site.

8. <u>Public Comment Period</u>. A 3-week comment period should be provided after release of the FS. The comment period should be announced through a press release issued 2 weeks before the comment period begins. Technical reports and summaries should be made available at the central information repository.

Section 5
REFERENCES

Bergstrom, R.E.; Piskin, K.; and Follmer, L.R. 1976. Geology for Planning in the Springfield-Decatur Region, Illinois. Illinois State Geological Survey. Circular 497.

Larsen, Jean I. 1973. Geology for Planning in Lake County, Illinois. Illinois State Geological Survey. Circular 481.

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United States Environmental Protection Agency. September 1974. Characterization and Control of Asbestos Emissions from Open Sources. Environmental Protection Technology Series. EPA-650/2-74-090.

United States Environmental Protection Agency. 1980. EPA Water Quality Criteria summarized from Federal Register, Volume 45, No. 231, Friday, November 28, 1980.

United States Environmental Protection Agency. July 1982, Asbestos.

APPENDIX A

MEMORANDUM

TO: File

FROM: Jim Schneider/CH2M HILL

DATE: July 19, 1983

SUBJECT: Site Visit Report
Johns-Manville Sales Corporation
Waukegan, Illinois

PROJECT: W65005.00/CH2M HILL
01-5VA5.0/EPA

This report summarizes the site visit conducted on July 19, 1983, as part of the RAMP preparation activities for the Johns-Manville site in Waukegan, Illinois.

The following people participated in site entry:

Jim Schneider/RSPM/CH2M HILL/Portland
Roberta Fine/CH2M HILL/Milwaukee
Mark Lepkowski/CH2M HILL/Milwaukee
Carolyn Lown/Schiff Hardin & Waite/Chicago
Jim Scott/Plant Manager/Johns-Manville/Waukegan
Rick Jonas/Plant Engineer/Johns-Manville/Waukegan

The CH2M HILL staff arrived at the Johns-Manville plant site at about 1:00 pm. Immediately prior to the site entry, the above personnel and Mr. Luke Mutaw of Johns-Manville met in an office at the Johns-Manville plant in Waukegan to briefly discuss the purpose of our visit. J. Schneider said that the purpose of the visit was to walk through the waste disposal site to observe the general conditions in the disposal site area, and take pictures. He also briefly outlined the purpose and scope of a RAMP. After this, the personnel listed above (without L. Mutaw) boarded two vehicles and drove completely around the periphery of the site on an access road.

At approximately 1:30, the CH2M HILL vehicle containing the safety equipment was parked at a location northwest of the existing disposal area on Johns-Manville property. CH2M HILL staff dressed out in accordance with the Site Safety Plan developed for the visit. The CH2M HILL staff then rode on the tailgate of a Johns-Manville vehicle to the friable asbestos disposal pit located in the southwest portion of site. From this point, the walk-through proceeded in a generally easterly direction to the scrap disposal area, then north to the southern boundary of the 33-acre settling basin, then back approximately by the route of entry to the friable asbestos disposal pit, then north past the South Pump House to the southern boundary of the settling basin that receives the discharge from the South Pump House. The approximate route is shown on the attached map. After this, all personnel returned to the Johns-Manville vehicle parked in the vicinity of the friable asbestos disposal pit. At approximately 2:10 p.m., the site visit was terminated due to temperatures in the 90's and the potential for heat stress. CH2M HILL personnel returned on the Johns-Manville vehicle tailgate to the vicinity of the CH2M HILL vehicle.

Photographs were taken by J. Schneider and summarized in a photo log.

The following general observations were made during the course of the site visit:

- The friable asbestos disposal pit is roughly circular in plan, on the order of 100 to 200 feet in diameter and perhaps 30 feet deep. The pit appears to have been excavated in previously deposited waste: layers of refuse deposited in the past were observed in the south pit wall. No recently deposited asbestos containers were visible in the pit. The friable asbestos is reportedly disposed of in the bottom of the pit. No disposal activity was observed at the pit during the site visit. The bottom of the pit was covered to a large extent by a gray material that J. Scott indicated to be waste granular material from production of roofing shingles. The material had been dredged from a settling basin located elsewhere on the site.

- Assorted reject products and other waste from the plant are hauled to the scrap dump in trucks, dumped, and left uncovered. J. Scott indicated that most of the materials visible did not contain asbestos. He said that many of the products produced at the plant were white in color but did not necessarily contain asbestos.

- The basins on the northern portion of the site are dredged from time to time when their depth becomes inadequate to provide sufficient solids settling and water storage for plant operations. The dredged materials are removed from the lagoons and placed in the dredge spoil disposal area, as indicated on the attached map. The material observed in this area consisted primarily of light gray to white fine-grained material that appeared from its hummocky, surface to have had a high moisture content when dumped.

- The 33-acre basin was observed from its south bank. The water in the basin was slightly turbid, but it was possible to see the bottom of the pond. It appeared to be several feet deep where it was observed.

- The water observed in the lower and upper basins adjacent to the South Pump House was turbid and light gray in color.

- At no location on the site did we observe any material that appeared to be naturally occurring soils that had been imported to cover any portion of the site. It appears that essentially all of the material exposed at the surface consists of waste products.

- There is a significant amount of vegetation growing on portions of the site, particularly on the north and east portions of the property. This vegetation consists of small trees, brush, and miscellaneous weeds and grass.

- J. Scott indicated that the process water discharged from the plant is cycled through the basins for settling and ultimately reused in plant processes. The pattern of flow described to us corresponds with that indicated on the map that was furnished with the previous report from Schiff Hardin & Waite (Document No. 019). This map was used as the base for the attached map.

- According to Johns-Manville staff, the water from the 33-acre settling basin discharges through a pipe into the "collection shoal," then seeps through the east dike of the collection shoal into the collection channel.

- Johns-Manville staff indicated that while a large amount of material that is being dumped in the area at present is white in color, very few of the products that the plant currently produces contain asbestos.

- A number of 55-gallon drums were observed in the sludge spoil area. J. Scott said that most of these drums had contained mold release compound, a product similar to liquid soap.

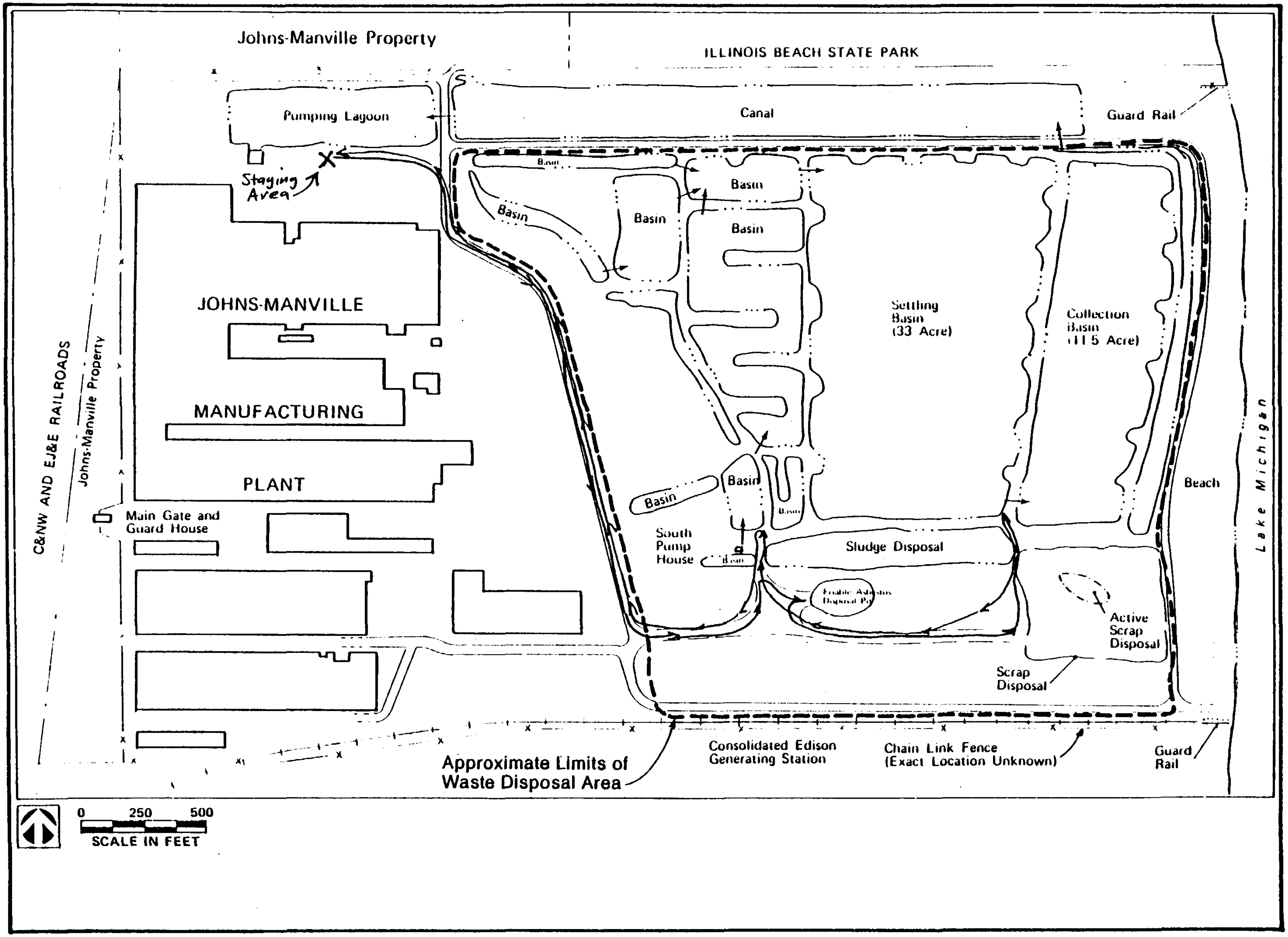
- The immediate vicinity around the site is sparsely populated. Immediately to the south of the site is the Commonwealth Edison Waukegan generating station, a coal-fired power plant. To the north is Illinois Beach State Park. Lake Michigan lies to the east, and the Johns-Manville plant property lies to the west. Approximately ¼ mile to the west of the western portion of the dump area, the Waukegan residential area begins with numerous residences.

- The site is currently active and partially fenced. Existing fencing surrounds the north, west, and south portions of the Johns-Manville plant. The south fence extends along the south border of the property almost all the way to Lake Michigan. At the Lake Michigan beach, the fence is replaced by a steel guard rail and posts that extends all the way to the edge of the water. J. Scott stated that this is intended to keep four-wheel drive vehicles off of the Johns-Manville property. The fence was not observed to the north, but J. Scott indicated that the fence along the north side of the plant ran to the canal and that there was also fencing in the vicinity of the Illinois Beach State Park property. There is apparently no fence along the canal. The eastern portion of the site faces Lake Michigan and is unfenced.

- Several warning signs were observed inside the fence, facing south, on the south edge of the property. These could be seen from the public access road running between the Johns-Manville property and the Commonwealth Edison property.

- It appeared that nearly the entire north slope of the site was composed of stacked pieces of pipe and rolled-up roofing material. Similar types of material were observed (to a lesser extent) at the north end of the west slope of the dump.

- In general, the site appears to be a pile of waste that is well above the surrounding natural ground level. It is not known whether or not any excavation was made before disposal was started.



Johns-Manville Property
ILLINOIS BEACH STATE PARK
Pumping Lagoon
Canal
Guard Rail
Staging Area
Basin
Basin
Basin
Basin
Basin
Settling Basin (33 Acre)
Collection Basin (11.5 Acre)
JOHNS-MANVILLE
MANUFACTURING
PLANT
C&NW AND EJ&E RAILROADS
Johns-Manville Property
Main Gate and Guard House
Basin
Basin
South Pump House
Sludge Disposal
Active Scrap Disposal
Beach
Lake Michigan
Scrap Disposal
Approximate Limits of Waste Disposal Area
Consolidated Edison Generating Station
Chain Link Fence (Exact Location Unknown)
Guard Rail
0 250 500
SCALE IN FEET

W65005.00

APPENDIX B

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October 14, 1983

Task 23

Technical Support to Region V Re Asbestos Waste Site (Johns-Manville Corp.), Waukegan, IL

by

Jean Chesson
Task Leader

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2030 M Street, N.W.
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EPA Contract No. 68-01-6721

and

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Design and Development Branch
Exposure Evaluation Division
Office of Toxic Substances
Office of Pesticides and Toxic Substances
U.S. Environmental Protection Agency
Washington, D.C. 20460

DISCLAIMER

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

EXECUTIVE SUMMARY

The Johns-Manville Corporation operates a landfill disposal facility for asbestos waste material adjacent to its manufacturing plant at Waukegan, Illinois. As part of the evaluation of this asbestos waste site being conducted by EPA's Region V Office, it is necessary to estimate airborne concentration levels of asbestos emanating from the site.

Two previous air monitoring programs have been conducted at the site, one in 1973 and the other in 1982. Although quantitative estimates of airborne asbestos concentration levels were produced, neither program was conducted in a manner that allows the data to be evaluated objectively with respect to representativeness, accuracy, and precision.

A monitoring program has been designed based on recent EPA experience and guidelines on asbestos sampling and analysis. In addition a quality assurance (QA) plan has been developed to govern the conduct of the program. The design specifies:

1. Sampling parameters
2. Analytical methods
3. QA requirements
4. Statistical summaries and data interpretations

A brief sampling test will be conducted at the outset to confirm decisions based on evaluation of historical data regarding sampling parameters such as flow rate and duration of sampling. With the exception of potential changes resulting from the test, the highlights of the recommended program are:

1. Collection of 30 samples, 25 on-site and 5 at a background site;
2. Sampling at 5 locations on-site and at 1 background site;
3. Collection of samples on 5 days at each location;
4. Collection of 12-hour samples on each day at each waste-site location and at the background site, at the sampling rate of 15 liters per minute;
5. Analysis of the samples using Transmission Electron Microscopy (TEM);
6. Analysis of 14 QA samples (blanks, duplicates, replicates, external laboratory) using TEM;
7. Collection of data on wind direction and speed, and compilation of other relevant ancillary information required for QA; and
8. Documentation of all QA activities.

I. STUDY OBJECTIVES

The Johns-Manville Corporation operates an asbestos waste disposal site in Waukegan, Illinois. The EPA Region V Office is conducting an investigation of the site to assess the degree of hazard from airborne asbestos and the need for remedial action. As part of the EPA investigation, measurements of airborne asbestos concentrations at the site will be used to estimate the extent to which concentrations are elevated compared to background levels, and the exposure potential for residents of surrounding areas.

The objectives of the study reported here are two-fold:

- To evaluate existing asbestos measurement data at the waste site for information on the "strength" of the site as a source of asbestos fibers; and
- To specify an air monitoring plan for the collection and analysis of additional data on airborne asbestos concentrations.

Two air monitoring studies have been conducted at the waste site. The results of these studies are evaluated for representativeness, accuracy, and precision. One study also provided estimates of asbestos levels in surrounding neighborhoods based on atmospheric dispersion modeling results. These estimates are evaluated for usefullness in hazard assessment.

With respect to additional air monitoring, the specified plan contains information on all aspects of measuring airborne asbestos at the Johns-Manville site. Specific components of the plan include a sampling design, sampling instrumentation and procedures, sample analysis, quality assurance, and statistical evaluation of the results.

II. DESCRIPTION OF THE SITE

The Johns-Manville Corporation maintains an asbestos products manufacturing plant in Waukegan, Illinois, located on the Lake Michigan shoreline. A landfill for the disposal of asbestos waste material is adjacent to the manufacturing facility. The landfill occupies about 0.48 km^2 (120 acres) and features (1) a pit 15 m (50 feet) deep and 46 m (150 feet) in diameter where friable waste is deposited, (2) an area of about 0.14 km^2 (35 acres) where most of the dry material has been deposited, and (3) a series of lagoons delineated by berms composed of dry landfill material (see Figure 1). On-site waste consists of both friable and nonfriable materials. Although only friable materials continue to be dumped (total friable waste averages about 100 kilograms per month), previously disposed nonfriable material appears to have degraded over time. A thick coating of light-colored dust covering the entire site is evidence of material degradation. (Most of the nonfriable waste is white or light-colored.)

The waste disposal operation involves filling, transporting, and emptying an enclosed container in the bottom of the 15 m pit. The waste is then covered immediately with soil. Asbestos could become airborne at various points in this process, the most obvious being during the container dumping procedure. The application of soil cover could also suspend fibers. However, suspension of degraded materials (light-colored dust) by the wind would appear to be the major source of airborne fibers.

III. MEASURING AIRBORNE ASBESTOS

A short discussion of methods for measuring airborne asbestos will prove useful in setting the context for both the evaluation of previous air monitoring at the Johns-Manville site, (Section IV) and recommendations for additional air

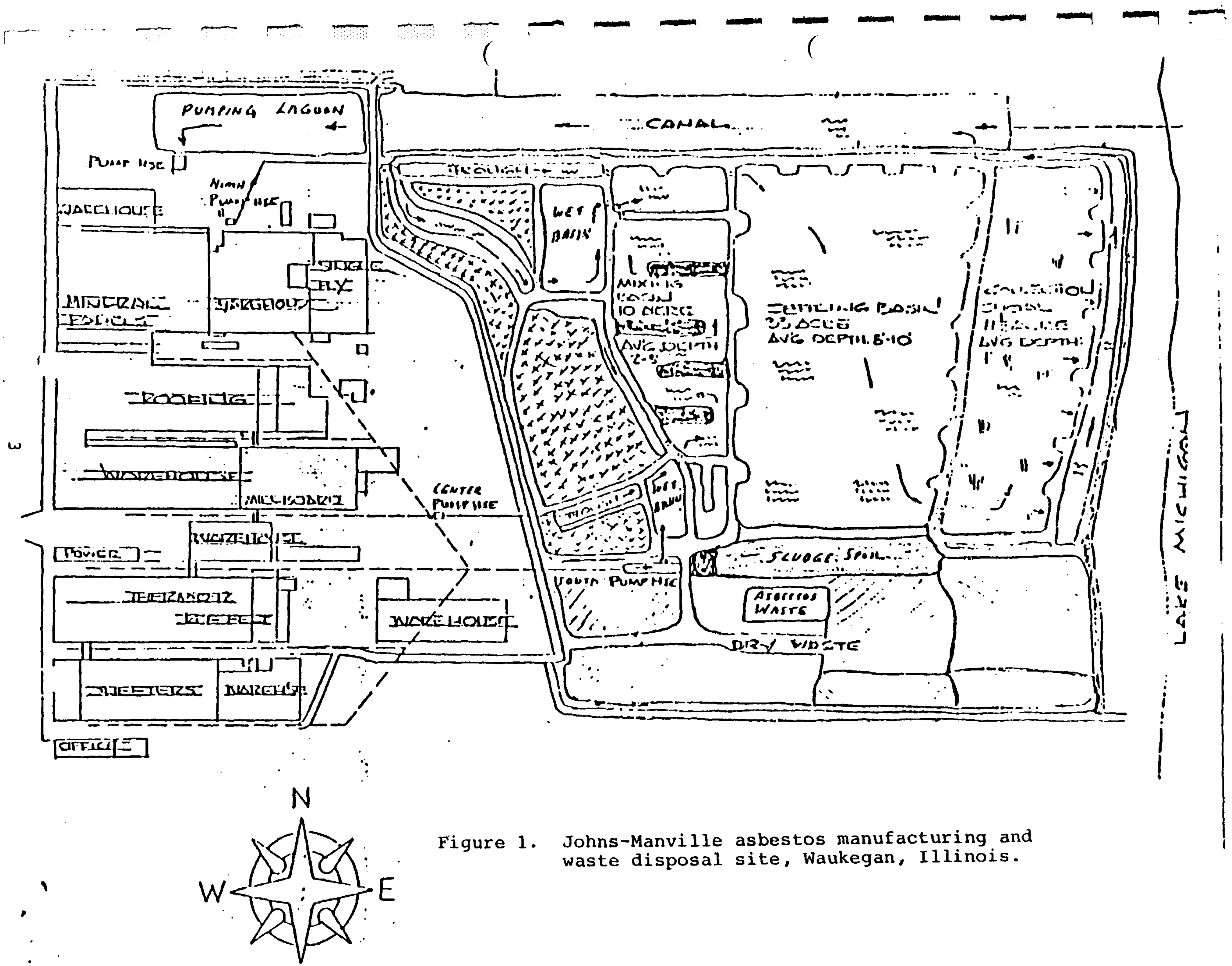

Figure 1. Johns-Manville asbestos manufacturing and waste disposal site, Waukegan, Illinois.

monitoring (Section V). Specifically, conclusions regarding the usefulness of existing air monitoring data and specifications for additional monitoring will reflect the utility and limitations of sampling and analysis procedures.

Airborne asbestos fibers are collected by drawing a measured volume of air through a filter which traps the fibers. The collected fibers are then examined microscopically and those on a small section of the filter are counted and sized. The concentration of fibers in the air from which the sample was taken is calculated based on the number and dimensions of fibers counted, the size of the filter area examined, and the total volume of air sampled. Concentrations are expressed either as fiber counts (fibers per cubic meter [f/m^3]) or fiber mass (nanograms per cubic meter [ng/m^3]).

Two general microscopic methods have been employed to examine asbestos fibers--one based on light microscopy and one based on electron microscopy. More specifically, the light microscopic method employs a phase contrast microscope (PCM) and the electron microscopic method typically employs a transmission electron microscope (TEM).*

The PCM technique has been used for many years to determine compliance with the Office of Health and Safety Administration (OSHA) standard for exposure to asbestos fibers in the industrial workplace. Measurement using PCM is an inexpensive method but has several fundamental limitations. First, PCM is unable to distinguish asbestos from nonasbestos fibers; instead, all fibers are counted. Second, PCM cannot detect very thin fibers--those less than about 0.3 μm in diameter--and the standard measurement protocol is designed to count only those fibers longer than 5 μm in length. As a result, PCM measurements can be highly misleading where (a) many nonasbestos fibers are present, or (b) asbestos fibers have dimensions below the stated limits.

* Scanning electron microscopes have also been used, primarily on an experimental basis.

The alternative method based on TEM overcomes limitations associated with PCM. The higher magnification capabilities of the electron microscope allow fibers as thin as 0.01 µm to be detected. (Counting protocols usually specify that only fibers with at least a 3:1 aspect [length-to-width] ratio should be counted.) In addition, chemical and/or crystallographic analyses are typically made on fibers observed by TEM to establish whether or not they are asbestos. The major disadvantage of using TEM is its high cost and the fact that few laboratories are qualified to perform TEM asbestos analysis.

A less significant limitation of TEM involves sample preparation procedures. If a filter is contaminated with nonasbestos materials to the extent that these materials would interfere with asbestos fiber examination, then the filter should be combusted (ashed) and the remaining material refiltered before microscopic examination (USEPA 1978). Ashing and refiltering will break fibers and, as a consequence, distort the meaning of fiber counts. (For this reason, fiber concentration measurements are typically expressed in mass units [ng/m^3]) when these sample preparation procedures are employed.) Ashing and refiltering also runs the risk of destroying or losing some fibers.

Another problem which applies to both PCM and TEM methods involves measuring aggregations of fibers. Since counting and sizing individual fibers which comprise bundles or clumps is not possible, the true concentration of asbestos in mass units will be underestimated to the extent that airborne fibers are present as aggregates.

Comparing the limitations of both PCM and TEM, EPA now recommends that TEM be used to measure asbestos fibers collected from the ambient air and in all nonindustrial indoor settings. However, PCM is still used by many to measure asbestos levels in nonindustrial as well as industrial settings. The attraction of PCM appears to be the perceived ability to compare PCM results with the OSHA exposure standard. However, the OSHA standard was designed for application in the asbestos industry where many if not all fibers measured by PCM are asbestos. As noted above, all fibers measured are not necessarily asbestos in other settings. In addition, the current OSHA standard was set to protect against asbestosis only. It does not appear to be stringent enough to protect against asbestos-induced cancer.* Thus, the comparison of total fiber concentrations as measured by PCM in nonindustrial settings with the OSHA standard is not likely to be meaningful.

IV. EVALUATION OF AVAILABLE DATA ON LEVELS OF AIRBORNE ASBESTOS AT THE SITE

Levels of airborne asbestos fibers have been monitored twice at the Johns-Manville asbestos waste site, once in 1973 and once in 1982. In addition, levels in a broad area surrounding the site were estimated with an air quality model based on the 1973 monitoring results. The evaluation of these studies that follows consists of a characterization of the methods, and an assessment of the results for representativeness accuracy, and precision.

A. The Illinois Institute of Technology Research Institute Study

The Illinois Institute of Technology Research Institute (IITRI) conducted a brief monitoring and modeling study of the Johns-Manville site in December 1973 (USEPA 1974). This was part of a larger EPA-sponsored study of asbestos emissions from open sources.

---

* As of July 1, 1976, the OSHA standards were set at 2 f/cm^3 (2 million f/m^3) averaged over 8 hours and a ceiling level not to exceed 10 f/cm^3 "at any time". OSHA is now evaluating the effect of lowering the 8-hour standard to either 0.5 or 0.1 f/cm^3 in order to protect workers against cancer, as published in the FEDERAL REGISTER (47 FR 1807).

1. Description and Results of Air Monitoring

Monitoring was conducted on December 8, 1973, at three on-site locations (see Figure 2). Specifications of the sampling and analysis procedures are shown in Table 1. Samples were analyzed by both phase contrast microscopy (PCM) and transmission electron microscopy (TEM). Environmental conditions during the sampling period were as follows: air temperature--approximately 0° C (32° F), wind direction--south to southwest, and wind speed--4.5 to 6.7 m/sec (10-15 mph). Operations at the site were continuous, with waste dumped from open trucks down the slope of a 9 m (30 ft) high pile. Waste consisted of broken asbestos-cement pipe, floor tile, asbestos paper and building board, and waste from the settling ponds and baghouses. The top surface of the pile was covered with soil, presumably on a daily basis.

The results of the air monitoring study are summarized in Table 2.

2. Description and Results of Air Quality Modeling

An atmospheric dispersion model was employed to estimate the impact of fiber release at the Johns-Manville waste site on air levels in surrounding areas. The air monitoring results at the site were used to estimate asbestos emission rates and local meteorological conditions were used to estimate transport of fibers from the site. The highest levels estimated were for the nearest residential neighborhoods--8 fibers/m^3 based on PCM air monitoring results and 2 x 10^6 fibers/m^3 based on TEM monitoring results.

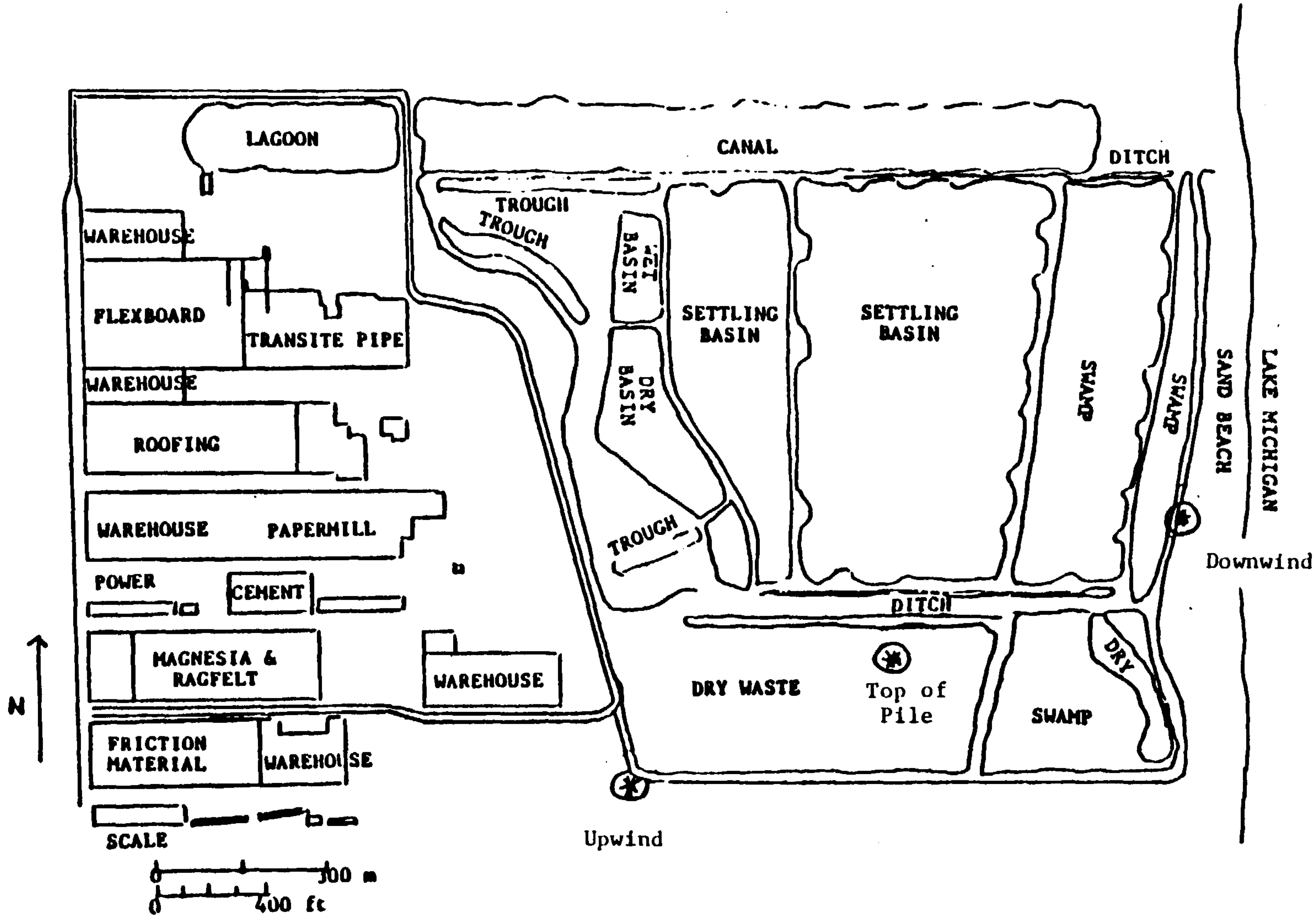

Figure 2. Monitor locations in the IITRI study.

Table 1. Specifications of IITRI Air Monitoring Study

Sampling instrument	Type of filter	Sampling time	Sample volume	Sample preparation	Analytical instrument	EM magnification
Not noted	Millipore with 0.8 μm pore size (filter material not noted)	At least 3 hours	97 - 156 m^3	Filter dissolved in acetone, fibers deposited on carbon substrate of EM grid	PCM and TEM, no crystalline or chemical analysis of fibers	TEM:16,000x; fiber resolution = 0.020 μm diameter PCM:500x

Table 2. Results of the IITRI Asbestos Monitoring Study of the Johns-Manville Asbestos Waste Site, 1973

Monitor Location	Fiber Concentration (f/m^3)[a] PCM	TEM
Upwind	1.7×10^2	5×10^7
Top of Pile	1.6×10^2	7.5×10^7
Downwind	2.3×10^3	4.3×10^7

[a] These are the results of measuring the fibers on a single filter at each location. Sampling and analysis specifications are shown in Table 1. Monitor locations are shown in Figure 2.

[b] Measurements made with a phase contrast microscope.

[c] Measurements made with a transmission electron microscope.

3. Evaluation of Monitoring and Modeling Results

The IITRI monitoring results are problematic for the following reasons:

- The results may reflect significant bias since the ground was reported to be frozen at the time of sampling, thus greatly reducing the tendency for fibers to become airborne;
- Rain during the day before sampling commenced may have cleansed the air of many fibers;
- Too few samples were collected (only three locations and one time period) to capture the expected spatial and temporal variation in levels of airborne asbestos;
- No quality assurance measures were employed (at least none are reported). Thus no judgement can be made regarding the accuracy of the results.
- Descriptions of sampling instruments and procedures are too sketchy to judge the adequacy of sampler flow rate and filter type; and
- No attempt was made to identify the mineral content of the fibers. Thus, no estimate of asbestos concentrations can be made.

The air quality modeling results can be questioned on the same grounds, since the estimated asbestos emission rate for the waste site was derived from the monitoring results. Also, additional uncertainty is introduced by the use of meteorological data from the local airport since on-site data were not available.

4. Conclusions

The IITRI study provides very little useful information on levels of airborne asbestos at the Johns-Manville site. Apart from the fact that the study is 10 years old and site conditions have changed appreciably, fundamental problems with sample collection and analysis render the results of little value even as reference points. As extensions of the monitoring results, the air quality modeling estimates are similarly flawed.

B. The Ecology and Environment, Inc. Study

Air monitoring of the Johns-Manville's site was conducted on April 28, 1982, by Ecology and Environment, Inc. (EEI), under contract to the USEPA. The samples collected were analyzed using TEM both by an independent laboratory (EMS Labs, Inc.) and by the Johns-Manville Corporation. The EEI/EMS results were also reviewed by scientists retained by the Centers for Disease Control (U.S. Department of Health and Human Services).

1. Description and Results of Air Monitoring

Sampling was conducted during a single day at the three locations shown in Figure 3. The temperature was 4.5°C (40°F), winds were from the northwest at 4.5-6.7 m/sec (10-15 mph), and no rain fell during or 24 hours before sampling. Sampling and analysis specifications are shown in Table 3.

The results of the EEI study are shown in Table 4. Analytical measurements made by both EMS and Johns-Manville laboratories are included. The concentration values shown in Table 4 are weighted averages of two samples collected at each monitor. (The dichotomous sampler employed by EEI separates the particles collected into two size fractions by aerodynamic diameter [less than 2.5μm and 2.5 - 15μm]). As noted in a June 30, 1983, memo from Johns-Manville to the EPA Region V Waste

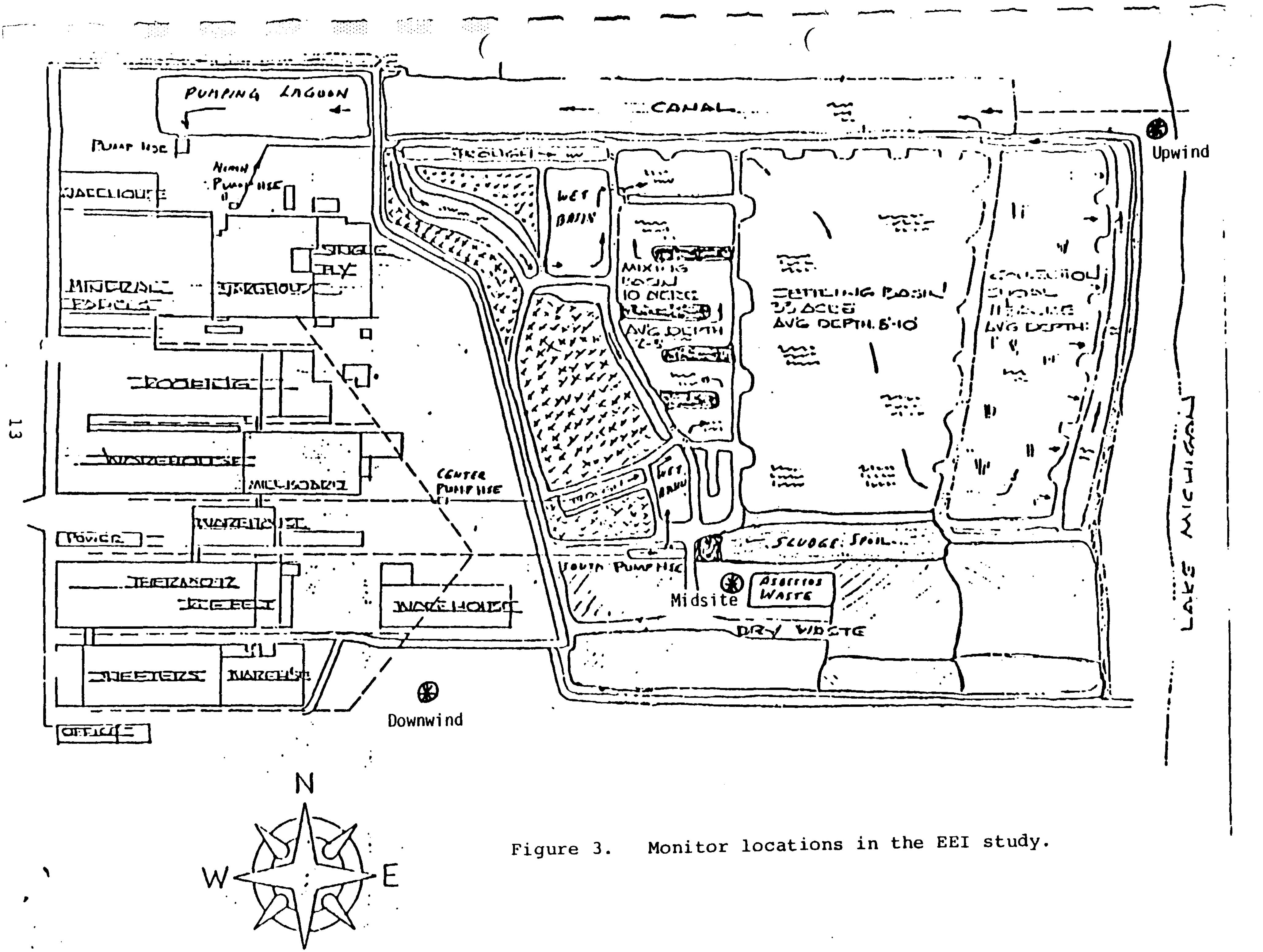

Figure 3. Monitor locations in the EEI study.

Table 3. Sampling and Analysis Specifications of EEI Air Monitoring Study

Sampling instrument	Flow rate	Sampling time	Type of filter	TEM analysis--sample preparation and magnification		Asbestos identification	
				EMS[b]	J - M[c]	EMS[b]	J - M[c]
Dichotomous sample	1.67 and 15.03 ℓpm[a]	7.5 Hours	Cellulose ester membrane, 0.8 μm pore size	Ashing and re-filtering on 0.1 m Nucle-filters deposition on EM grids using modified Jaffe Wick method; 20,000x magnification; 2 - 20 fields examined	"USEPA recommended methodology"[d]; 20,000x magnification; at least 10 fields examined	Electron diffraction to identify asbestos	Electron diffraction and energy dispersive x-ray analysis to identify asbestos

[a] These are the flow rates for the coarse and fine mode collection chambers, respectively.

[b] EMS - EMS Laboratory

[c] J-M - Johns-Manville Corp.

[d] Presumably, the methodology in USEPA, 1978.

Table 4. Results of the EEI Asbestos Monitoring Study at the Johns-Manville Asbestos Waste Site, 1982

Monitor location	Asbestos concentration[a]			
	Mass (ng/m^3)		Fiber Counts (f/m^3)	
	EMS[b]	J - M[c]	EMS[b]	J - M[c]
Upwind	5	--[d]	$.1x10^6$	--[d]
Midsite	288	167	$1.4x10^6$	$0.4x10^6$
Downwind	189	24	$2.1x10^6$	$0.5x10^6$

[a] These are the results of measuring asbestos fibers on a single filter at each location. Transmission electron microscopy was the measurement method. Sampling and analysis specifications are shown in Table 3. Monitor locations are shown in Figure 3.

[b] EMS Laboratory results.

[c] Johns-Manville results.

[d] J-M believes the filter was damaged.

Management Division, the correct way to calculate total sample concentrations is to weight the results for the "fine" and "coarse" fractions by the amount of air sampled.*

2. Evaluation of Results

The EEI air monitoring study is an improvement over the IITRI study in a number of areas. First, the meteorological conditions were more conducive to observing wind-generated airborne asbestos. Conditions were dry with temperatures above freezing and wind velocities were substantial. Second, the samples were analyzed by TEM and the fibers were identified as asbestos. Moreover, the analysis of the same filters by two independent laboratories (EMS and Johns-Manville) provides some information on the reliability of the measurements.

One important deficiency of the EEI study involves the number of samples drawn and the location of the monitors. Since the goal of the monitoring program is to gauge the quantity of asbestos fibers released over the entire site by measuring the on-site levels of airborne asbestos, air samples should be taken at various points within the site and at various times over an extended sampling period to capture the spatial and temporal variation in asbestos concentrations. Three sampling locations and one 7.5-hour sampling time are not sufficient to produce acceptably accurate and precise estimates of air concentrations.

A second deficiency is the lack of sampling in a "background" location. The significance of the asbestos concentrations on-site should be judged, in part, by comparison to measured air levels at a site unaffected by the Johns-Manville waste site or any other source of asbestos

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* Due to the design of the dichotomous sampler, the flow rate through the chamber which entrains the larger particles is about 10% of the flow associated with the smaller particles.

fibers. The selection of a "background" site, and the sampling design (duration and frequency of sampling) implemented there are critical considerations. EEI apparently selected the upwind monitor located slightly off-site to represent background concentrations. However, this location is much too close to the waste site to satisfy the criteria for a background site.

3. Conclusions

The results of the EEI study suggest that levels of airborne asbestos may be elevated at the Johns-Manville waste site. This conclusion assumes that asbestos concentrations at background sites in Waukegan approximate typical levels observed at urban background sites elsewhere (1-10 ng/m^3) (Nicholson 1971). Additional air monitoring both on- and off-site will be necessary to confirm this preliminary conclusion.

V. PLAN FOR ADDITIONAL MONITORING

Specifications for a new air monitoring study are presented in this section. Included are discussions of air sampling, sample analysis, quality assurance procedures, and data interpretation.

A. Sampling Plan

As discussed in Section I, the purpose of air monitoring is to estimate levels of airborne asbestos at the Johns-Manville site and to compare them with levels at sites which are not influenced by disposal site activities or other sources of asbestos. This requires estimation of both average concentrations and the variability of measured levels at each site. The sections which follow describe considerations for selecting (1) the background site, (2) the number of samples required for various levels of precision in the measurements,

(3) the location of monitors at each site, and (4) the sampling times and volumes. The final section describes sampling instrumentation and procedures.

1. Background Site Selection

A desirable location for a background site is one far upwind from the waste disposal site. Given the expected predominance of winds from the east, west, northeast, and southwest (and thus the low probability of northerly winds) due to lake/land effects at the Johns-Manville site,* a location to the south of the plant should be sought for a background site. To assure minimal influence from the waste site, a distance of at least 5 km is recommended. The site itself should be a relatively homogeneous area in terms of land use, and should not be influenced by any other source of asbestos.

Of particular importance is the location of tire stores or automobile repair shops where brakes are repaired. Since asbestos is frequently used in brake materials, brake repair operations may be a significant source of airborne asbestos.

Sites near gravel or dirt roads should also be avoided for two reasons. First, these sites may be very dusty and, thus, overloading of collection filters may become a problem. Second, some communities have used asbestos-containing crushed stone for road paving. Traffic on these roads may suspend asbestos fibers.

Any data on airborne asbestos from previous air monitoring studies in the Waukegan area should be used in selecting a background site. Low measurements near candidate sites would confirm their suitability.

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* Prevailing annual wind patterns at a local airport are NE-SW. A lake-side location should accentuate this pattern and further minimize northerly winds.

2. Number of Samples

The number of samples needed for a desired level of precision in the results depends on the magnitude of the variability associated with all phases of the sampling and analysis process. If several air samples are taken in the same general area but at slightly different locations (e.g., at different points within the waste disposal site) or at different times at the same location, the measurements of sampled material will differ from one another. These differences constitute the sampling component of variability. Sampling variability is due to random fluctuations in the population being sampled, and to factors such as wind speed and direction, atmospheric stability conditions, and the distance from emission sources such as dumping activities or roadways. These latter factors may be viewed as systematic influences on sampling variability, and potentially can be accounted for through sample design.

A second type of variability is that associated with the air sampling instrumentation and chemical analysis procedures. This is called analytic variability and is especially important for asbestos since asbestos fibers are difficult to detect and characterize. This variability can be further subdivided into variability between laboratories and variability within laboratories. Variability between laboratories is due to differences in types of equipment, interpretation of procedures, and analytical practices; variability within laboratories is due to differences between individual analysts (based on differences in experience and training) and differences between repeated readings obtained from the same sample by a single analyst as a result of variability in preparing a sample and in counting fibers.

Due to the sources of variability enumerated above, the measured concentration of asbestos in a single air sample collected at one location for a short period of time is unlikely to be equal to the concentration averaged over the entire site and for a longer time. The degree to which a single estimate departs from the area-wide, long-term value is called the estimation error. This error can be reduced by forming an average of samples taken at more locations, at more times, and by repeated measurement in the laboratory. The magnitude of error will depend both on the number of samples and the total sampling and analytic variability of the measurements.

In order to calculate the number of samples required to achieve a desired estimation error, the amount of expected variability in the measurements must be approximated or assumed. Some data are available from which estimates can be made of variability associated with the analytical method (between and within laboratories), but the spatial and temporal variability of airborne asbestos at the Johns-Manville site is unknown. Therefore, required sample sizes have been calculated assuming a range of possible variabilities, where variability is measured relative to the expected concentration using a term called the coefficient of variation (standard deviation divided by the mean). A large coefficient of variation (e.g., greater than 100%) reflects a high level of variability.

Table 5 shows the relationship between the coefficient of variation, estimation error, and the number of required samples.* For example, if the coefficient of variation for the measurements is 100%, then taking 19 samples will "assure" that the estimation error is ± 60% of the "true" mean.† In other words, the average concentration for 19 samples should fall somewhere between 60% less than and 60% greater than the "true"

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* These calculations are based on several assumptions which may hold only approximately in practice. Therefore the sample sizes should be used only as a guide. See Appendix A for a discussion of the assumptions underlying the calculations.

† Although it is not possible to be absolutely sure that the "true" mean will fall within this interval, the probability is high. See Appendix A and footnotes to Table 5. "True" mean simply refers to the area-wide, long-term average.

Table 5. The Relationship Between Sample Size, Coefficient of Total Variation, and Estimation Error

Coefficient of total variation[a]	Maximum acceptable estimation error as a percentage of the true mean[b]	Required sample size[c]
100%	25%	78
	50%	25
	60%	19
	75%	14
	80%	13
	100%	10
150%	25%	160
	50%	48
	60%	35
	75%	25
	80%	22
	100%	16

[a] Standard deviation divided by the mean and expressed as a percentage.

[b] Based on the 95% confidence interval for the true mean calculated from the observed data.

[c] The number of samples required to ensure that the estimation error is less than the specified amount in the second column, with a probability of 90%.

mean. Increasing the sample size to 25 reduces the estimation error to ± 50% of the true mean. Once the samples have been collected and a sample average calculated, this average becomes the best estimate of the true mean and an actual estimation error is calculated from the sample variance. (This procedure is discussed in Appendix A.)

The two coefficients of variation in Table 5 (100% and 150%) have been selected based on limited data on (1) laboratory variability in measuring asbestos, and (2) temporal variability in particulate matter concentrations at a few sites.* Extrapolating from these data, the coefficient of total variability for airborne asbestos will likely be at least 100% and may be higher than 150%.

A minimum of 25 samples is recommended for the Johns-Manville site. This sample size would provide an estimation error of ± 50% of the true mean if the coefficient of variation if 100%, or ± 75% is the coefficient of variation is 150%.

For measurements of asbestos levels at background sites, a larger estimation error might be tolerable. For example, it may be sufficient to know only that the background concentration is less than some relatively low level, perhaps 30 ng/m^3. If the actual mean is 10 ng/m^3, then the maximum tolerable estimation error is $^{-100\%}_{+200\%}$ (or a one-side error of +200%). A sample size of 5 would be sufficient to "assure" that the estimation error was no larger than this limit. Five samples are thus recommended for the background site.

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* Very limited evidence suggests that the coefficient of variation in asbestos measurements due to variability between laboratories may be 50-90% (Steel et al. 1982) and within laboratories, 30-40% (USEPA 1983). Temporal variability in 24-hour measurements of particulate matter at a sample of sites in Illinois (1980 data) produced a coefficient of variation which averaged about 45% (data from USEPA 1981).

To illustrate how the size of the estimation error influences interpretation of the monitoring results, suppose the measured mean concentration at the waste site were 200 ng/m^3 with an estimation error of $\pm$ 75%, and the mean at this background site were 10 ng/m^3 with an error of + 200%. Thus, we could say (with 95% confidence) that the waste site concentration is between 50 and 350 ng/m^3 and the background concentration is between 0 and 30 ng/m^3. In this example, we can be confident that the two concentrations are clearly different. The smaller the estimation errors, the easier it is to distinguish measured concentrations at the two sites.

3. Monitor Location

Since the air samples collected should be representative of typical concentrations at each site, they must capture both spatial and temporal variations in air levels. For the waste disposal site, five sampling locations and five sampling times are recommended, thus making a total of 25 separate samples. The sampling locations should be randomly selected within the following contrains: all locations should be at least 30-m from the boundaries of the site (to assure that measurements reflect on-site emissions), and the set of five locations should be approximately symetrical so as to capture high concentration irrespective of wind direction or distance from on-site "sources" (e.g., the disposal pit, roadways, the main landfill). One way to select the sampling locations is to construct a transparent template with a grid superimposed on a circle with five radial sectors (i.e., each sector subscribes 72°). The template is made about as large as a scale map of the waste site and placed on top of the map. The grid points on the template are numbered and a random number table used to select one location within each sector. Of course, if a selected location falls on water or another physically unsuitable spot, a substitute must be chosen within that sector. This design is intended to make the spatial variability in asbestos concentration random.

For the background site, a single monitor operated for the same five time periods is desirable. A single monitor will suffice since temporal variability is likely to be greater than spatial variability there. The specific location of the monitor will be governed by the usual considerations of security, access, and power availability. Locations near sources of dust should be avoided to prevent overloading of filters with particulate matter.

4. Sampling Times and Volumes

Based on the likelihood of day-to-day variability in on-site activity and meteorological conditions, sampling should be conducted on five separate days. Sampling periods of 12 hours for the waste site and background monitors are suggested. The start and end hours for the 12-hour sampling period should be timed to coincide with the start and end hours of the day work shift at the Johns-Manville plant. These sampling periods should smooth out hourly variability in asbestos levels. Where possible, days with different wind speed and direction should be chosen. In all cases, days with rain or days following precipitation by less than 24 hours should be avoided.

The total volume of air to be sampled is dictated by (1) the lower detection limit of the analytical methodology,* (2) total concentrations of particulate matter at the sites (and, thus, the potential for overloading filters), and (3) accepted operating practices for sampler flow rates and filter face velocities for airborne asbestos monitoring (Yamate 1982).

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* At least 10 asbestos fibers should be counted during EM examination (USEPA 1978).

Based on the findings of the EEI study and on other airborne asbestos monitoring studies (USEPA 1983), a total sample volume of 6,000-11,000 liters is recommended. A volume of 10,800 liters would be collected if the samplers were operated at a flow rate of 15 ℓpm (12 hrs. @ 15 ℓpm).

Filter "overloading" usually refers to gross clogging of the filter media. In the context of monitoring airborne asbestos, however, it may refer to contamination of the filter with substances other than asbestos fibers. This would require that the filtered material be ashed and refiltered prior to examination by EM. Since ashing and refiltering is not the preferred treatment, a pretest of the sampling plan is recommended to test for contamination.

Ashing and refiltering is also necessary if Millipore rather than Nuclepore filters are used. Millipore filters are sometimes used because they tend to retain fibers better during filter handling and transport. Thus, if the pretest reveals that contamination is a problem and that filter ashing will be necessary, the use of Millipore filters is recommended.

The pretest should consist of three monitors at a single waste site location. (The location should be one likely to produce high asbestos concentrations). The three monitors should be operated with three different flow rates: 5, 10, 15 ℓpm and the sampling time should be 12 hours. These combinations of flow rates and sampling times will produce high enough sample volumes to assure sufficient quantities of fibers for precise estimates at the highest rate (15 ℓpm) and low enough filter loadings to reduce contamination by nonasbestos material at the lowest (5 ℓpm).

After collection, the three pretest samples should be examined by the EM laboratory. Sample preparation should not include ashing and refiltering. If contamination by nonasbestos materials is still substantial at the lowest flow rate in the opinion of the electron microscopists, then the use of Millipore filters and ashing/refiltering procedures will be necessary.

Otherwise, the highest of the flow rates which still produces satisfaction fiber identification and measurement should be selected for the monitoring study.

5. Instrumentation and Sampling Specifications

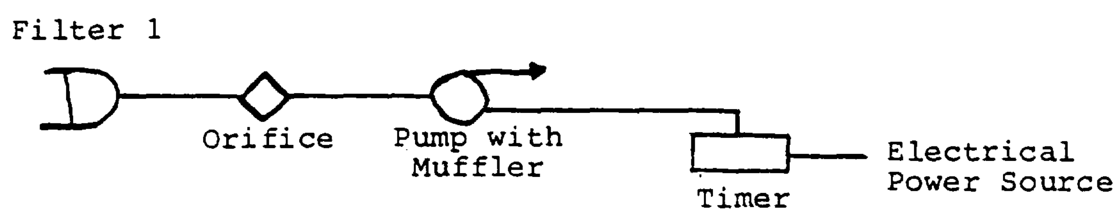
The following sampling procedures are within the class of procedures tested and recommended by EPA (USEPA 1978 and Yamate 1981). More specific information on selected procedures can be found in Appendix B.

a. Sample Setup

The sampling system should consist of:

- A Gelman magnetic-type open-face filter;
- A critical flow orifice;
- A diaphram pump with muffler;
- Associated plumbing and stand; and
- Timer (if desired).

The sampler setup is schematically represented as follows.



b. Specifications

- Flow rate: 5, 10, and 15 ℓpm for the pretest; one of the three will be selected for the study;

- Filter type: For the pretest and if non-asbestos contamination or fiber loss from the filter is not a problem: 47 mm polycarbonate Nuclepore with a 0.4μm pore size. At least two 47 mm cellulose acetate (Millipore type HA) filters with 5μm pore size should be used to support the Nuclepore filter.
  If contamination by nonasbestos particulate matter is a problem: 47 mm cellulose acetate (Millipore type HA) with 0.45 μm pore size.

- Filter height: 1.5 m

c. Sampling Protocol

1. Clean and dry filter holder.
2. Place filter in holder, assuring proper position, see filter handling section below.
3. Mount filter holder such that filter is in a vertical position (perpendicular to ground).
4. Start pump and position filter on holder before replacing holder top to prevent wrinkles.
5. Check plumbing for leaks and check filter holder to assure that it is free of vibration.
6. Check flow with flowmeter using manual control of pump.
7. Set automatic timer to desired on-off time settings (if timer is to be used).
8. Make appropriate logbook entries.
9. Conduct sampling.
10. After sampling period, check flow.
11. Rotate filter to a horizontal position and remove. Secure Nuclepore or Millipore filter in a petri dish with tape for proper handling and transport.

d. Filter Handling

During loading and unloading of the filter holder, the filters should be handled by forceps (not with fingers). When a filter is removed after exposure, it should be placed in the petri holder exposed side up and maintained in that position during the handling and transport of samples back to the laboratory. The samples should be hand-carried to the selected TEM laboratory in a container that will keep the petri dish in a horizontal (flat) position at all times (handling, transport, and storage).

The chain-of-custody system should be followed at all times (see Appendix B). A chain-of-custody record, therefore, will be kept on each filter.

Field blanks should be randomly selected at each site and for each sampling time (see Section V. C. below). Any dropping or mishandling of a filter after collection must be recorded. Each filter holder should be labeled according to a coding system. Laboratory blanks should be selected prior to field sampling (see Section V. C.). If possible, all filters at the same site should be from the same production lot.

e. Meteorological Observations

A wind vane and anemometer should be used to record wind direction and speed at the waste site. Recorded data should then be used to draw a wind rose for each day of sampling.

f. Logbook

An important part of any successful field program is the accurate observations and recordkeeping of the field team. At a minimum, logbook entries should include:

1. Name of field operator;
2. Date of record;
3. Number and location of site;
4. Position of sampler within site;
5. Brief description of site;
6. Corresponding filter number;
7. Sample flow rate at start of sampling period;
8. Start time;
9. Stop time;
10. Sample flow rate at end of sampling period;
11. Wind rose for the sampling period;
12. Description of meteorological conditions; and
13. Comments.

B. Sample Analysis

Air samples should be analyzed by transmission electron microscopy according to the methodology recommended by EPA (USEPA 1978 and Yamate 1981). Two alternative sample preparation protocols are employed. The first is utilized when the sample is collected on polycarbonate Nuclepore filters and, thus, when contaminmation by nonasbestos materials is not a problem. The second protocol is employed when the sample is collected on Millipore filters (typically cellulose ester or acetate). Which protocol is employed will be determined by the outcome of the pretest, as discussed previously. Brief descriptions of the two protocols are provided below; detailed sample analysis instructions appear in Appendix B.

1. Sample Preparation

a. Samples on Nuclepore Filter

When Nuclepore filters are used, the filter is coated after sampling with a carbon film using a vacuum process. The coated sample is then transfered to an EM grid using a modified Jaffe washer technique. In essence, the Nuclepore filter is placed on top of a carbon-coated EM grid and the filter is dissolved with chloroform. This deposits the carbon-coated sample directly on the grid.

b. Samples on Millipore Filters

Samples on Millipore filters must be ashed and then refiltered on a Nuclepore filter. The filters are first ashed at low tempertures to destroy the filter medium and combustible contaminants. The ashed residue is then redispersed by ultra-sonification and filtered with a Nuclepore filter.

2. <u>EM Examination</u>

Fibers are scanned, counted, and sized using an electron microscope at 20,000X magnification. Asbestos fibers are identified using selective area electron diffraction (SAED) analysis.

C. <u>Quality Assurance</u>

To ensure that the information obtained from the air monitoring study is reliable, a quality assurance (QA) program is needed. A formal QA plan has been developed according to the USEPA Office of Toxic Substances (OTS) requirements. This plan establishes organizational responsibilities and specifies procedures for implementing the plan. A complete QA plan is described in Appendix B; only the names of the team members need to be added. The key elements of the QA objectives are briefly described below.

As per OTS specifications, the plan covers, in more detail, the information on sampling and analysis procedures described on the previous page. However, its primary objective is to assure the quality of the data produced.

1. Documentation

Once completed, the QA program provides documentation of all procedures and activities. Such documentation raises the confidence of everyone associated with the study, especially potential users of the study results. Documentation also allows the handling and treatment of individual samples to be traced, if this is needed.

2. Corrective Action

A QA program will provide a mechanism for taking corrective action in response to the identification of data problems. Ideally, corrective action will be taken quickly enough to hold the loss of data to a small fraction of the entire data set.

3. QA Checks

A QA program establishes a series of checks to detect gross problems with data collection, handling, and analysis procedures. These include the analysis of blank samples, multiple analyses of single samples within a laboratory, and multiple analyses by more than one laboratory.

a. Field and Laboratory Blanks

During each sampling period and at each sampling site (i.e., waste disposal and background sites), at least one filter should be randomly selected as a field blank from the filter supply. Thus, a total of 10 field blanks is needed for this study. The blank filter is labelled and handled as any other filter but is not actually used for air sampling. A proportion of the field blanks (at least three) are submitted for analysis along with the test filters. The field blank provides a check for possible filter contamination. If contamination appears to be a possibility, additional field blanks can be analyzed to help determine the extent of the problem.

In a similar manner, at least three blank filters should be exposed on a laboratory bench during preparation and analysis of the samples. At least one of these is then analyzed to check for contamination in the laboratory.

b. Replicate and Duplicate Filter Analysis

As a means of quantifying analytical variability due to preparation and counting procedures, some filters should be selected at random for replicate analysis and some for duplicate analysis. Replicate analyses are done using two independent preparations from the same filter. Duplicate analyses are done by two different analysts using the same TEM grid preparation. It is recommended that a minimum of three filters be selected for each type of analysis and that further analyses be conducted if serious discrepancies appear. For this reason, it is important that all filters and sample preparations are carefully stored.

c. Interlaboratory Quality Assurance

A proportion of the filters (usually about 10% or three for this study) should be analyzed by a second laboratory. These filters are selected at random from the test filters and each is divided in half. One half is analyzed by the main laboratory and the other half by the second laboratory. If serious discrepencies appear, additional filters should be analyzed.

D. Statistical Evaluation

The data will be used to estimate a mean airborne asbestos concentration for the Johns-Manville waste disposal site and for the background site.* For each mean, a 95% confidence interval will be obtained to provide a measure of the estimation error. Comparisons between disposal site and background air levels can be made using standard statistical methods.

After the data have been colected and an estimate of variance is available, it is possible to evaluate the power of the statistical tests. In the case in which no statistically significant difference is found between two estimated means, the power calculation will provide a measure of how much confidence one can have in that conclusion.

The results from the various QA samples (field blanks, external laboratory, replicate, and duplicate samples) will be compared with the appropriate original analyses. The small number of QA samples precludes formal statistical analysis. However, if inconsistencies or large discrepanices are observed, further QA samples can be analyzed since only a portion of each filter is needed for each analysis.

E. Summary of Sampling and Analysis Design

Table 6 summarizes the key elements of the recommended air monitoring program.

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* Averages could also be estimated for subareas within the waste site, but the confidence intervals for these estimates would be very large due to the small number of samples. Data on wind direction and speed will be used to judge the representativeness of the asbestos measurements for each site.

Table 6. Summary of Key Elements of New Air Monitoring Study

			Flow Rates		Type of Filter		EM Sample Preparation	
Site	Number of monitors	Sampling time	Pre-test	Study	Pre-test	Study	Pre-Test	Study
Waste	5	5 days @ 12 hrs/ day	5, 10, & 15 ℓpm[a]	5, 10, or 15 ℓpm	Nuclepore	Nuclepore or Milli- pore[b]	Carbon coating only	Carbon coat- ing only or preceded by ashing & re- filtering[c]
Background	1	5 days @ 12 hrs/ day	--	5, 10, or 15 ℓpm[a]	--	Nuclepore or Milli- pore[b]	--	Carbon coat- ing only or preceded by ashing & re- filtering[c]

[a] Depends on results of the pre-test, 15ℓpm recommended unless a lower rate elimates contaimination by organic materials.

[b] Use Nuclepore filters if nonasbestos contamination is not a problem (based on results of pre-test); otherwise, use Millipore filters.

[c] Use ashing and refiltering procedures if Millipore filters are used.

F. Cost and Time Estimate

The air monitoring study should cost between $55,000 and $65,000. The estimated time to complete the study is 3-1/2 months. Cost components are shown below.

- Sample collection

2 staff x 12 hrs/day x 10 days @ $65-70/hr =	$16,000 - 17,000
• Sample analysis	
45 samples @ $600-700 =	27,000 - 32,000
• Quality Assurance and Reporting	12,000 - 16,000
Total	$55,000 - 65,000

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Appendix A. Calculating Sample Sizes

The term "estimation error", as used in Section V. A.2, refers to half of the length of the 95% confidence interval for the true mean. This confidence interval will be calculated from the data after they have been collected and will indicate the magnitude of the error associated with the estimation of the true mean. If the coefficient of total variation is small and/or the sample size is large, then the confidence interval will be short and one will be confident that the true mean is not very different from the value estimated from the data. By "confident" it is meant that 95% of the time the procedure for calculating a 95% confidence interval results in an interval which actually includes the true mean.

The formula for the 95% confidence interval is:

$$\bar{x} \pm t_{(0.025,n-1)} \sqrt{s^2/n}$$

where $\bar{x}$ and s^2 are the calcualted sample mean and sample variance, respectively, and $t_{(0.025,n-1)}$ is the upper 2.5 percent point of the t distribution with n-1 degrees of freedom. Note that

$t_{(0.025,n-1)} \sqrt{s^2/n}$ is the estimation error. The aim is to

choose the sample size n so that $t_{(0.025,n-1)} \sqrt{s^2/n}$

is not too large. Suppose it is decided that this quantity should be no larger than $d\mu$ where μ is the true mean and d is a fixed proportion. For example, if the estimation error is required to be no more than 60% of the mean, then d would be made equal to 0.6. Then n has to be chosen so that

$t_{(0.025,n-1)} \sqrt{s^2/n}$ is less than $d\mu$.

It is not possible to be absolutely sure that for a given sample size the resulting confidence interval is sufficiently small, but it is possible to attach a probability to the chance that it will be. For example, it is possible to find n such that the probability that the confidence interval is sufficiently small is 0.9 or 0.95, or any other desired level. If the desired level is $1-\beta$ then it is necessary to find n such that

$$P\left(t_{(0.025,n-1)}\sqrt{s^2/n} \leq d\mu\right) = 1-\beta.$$

This is equivalent to

$$P\left(\frac{(n-1)s^2}{\sigma^2} \leq \frac{(n-1)nd^2\mu^2}{\sigma^2(t_{0.025,n-1})^2}\right) = 1-\beta$$

If it is assumed that the n samples are independent observations from a normal distribution with mean μ and variance σ^2 then $(n-1)s^2/\sigma^2$ has a X^2 distribution with (n-1) degrees of freedom. The problem is thus reduced to finding n such that

$$\frac{(n-1)nd^2\mu^2}{\sigma^2\ (t_{(0.025,n-1)})^2} = X_{n-1} ,$$

where X_{n-1} is the upper (100%) β percentage point of the X^2_{n-1} distribution. Substituting $\sigma^2 = c^2\mu^2$ gives

$$n = \left(1 + \sqrt{1 + 4\ (t_{(0.025,n-1)})^2\ (c/d)^2\ X_{n-1}}\right)\ /2$$

which can be solved by trial and error.

Table A-1 shows the values of n for different values of the cofficient of variation (c), the size of the 95% confidence interval (estimation error) and different values of the probability of obtaining an error as small or smaller. For example, if the coefficient of variation is 100% and one wants to ensure with probability 0.95 that the estimation error is no greater than ±50% of the true mean, then 27 samples are required. If only 22 samples are collected then the probability is reduced to 0.8.

Table A-1. Sample Size Required to Estimate the Mean with a Desired Level of Precision with the Coefficient of Variation Set at 100% and 150%

Maximum acceptable estimation error (%)[b]	Probability of achieving acceptable estimation error		
	0.8	0.9	0.95
Coefficient of variation = 100%[a]			
25	73	78	81
50	22	25	27
60	17	19	20
75	13	14	15
80	12	13	14
100	9	10	11
Coefficient of variation = 150%[a]			
25	154	160	176
50	44	48	50
60	32	35	38
75	22	25	27
80	21	22	24
100	15	16	17

[a]Standard deviation divided by the mean and expressed as percentage

[b]The length of the 95% confidence interval for the true mean calculated from the observed data.

Appendix B. A Sample Quality Assurance Plan

The organization of this QA Plan conforms to USEPA OTS specifications. The plan includes asbestos sampling and analysis protocols and procedures to assume the quality of the data produced.

SECTION 1.0

QUALITY ASSURANCE PLAN

for

MONITORING AIRBORNE ASBESTOS CONCENTRATIONS AT THE JOHNS-MANVILLE CORPORATION ASBESTOS WASTE SITE, WAUKEGAN, IL.

Approved for:		Approved for:	
________________		________________	
Department Mgr	Date	________________	Date
QA Administrator	Date	________________	Date

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3.0 PROJECT DESCRIPTION

The Johns-Manville Corporation operates an asbestos waste disposal site in Waukegan, Illinois. The EPA Region V Office is conducting an investigation of the site to assess the degree of hazard from airborne asbestos and the need for remedial action. As part of the EPA investigation, measurements of airborne asbestos concentrations at the site will be used to estimate the extent to which concentrations are elevated compared to background levels, and the exposure potential for residents of surrounding areas.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

4.1 Organization

The project organization is given in Figure 1.

4.2 Responsibilities

4.2.1 Department Management

The individual representing Department Management shall be responsible for overseeing the project and will appoint a Project Manager and QA Administrator.

4.2.2 QA Administration

The QA administrator (QAA) shall review the QA plan, ensure that QA requirements are satisfied, and provide documentation to that effect to Department Management.

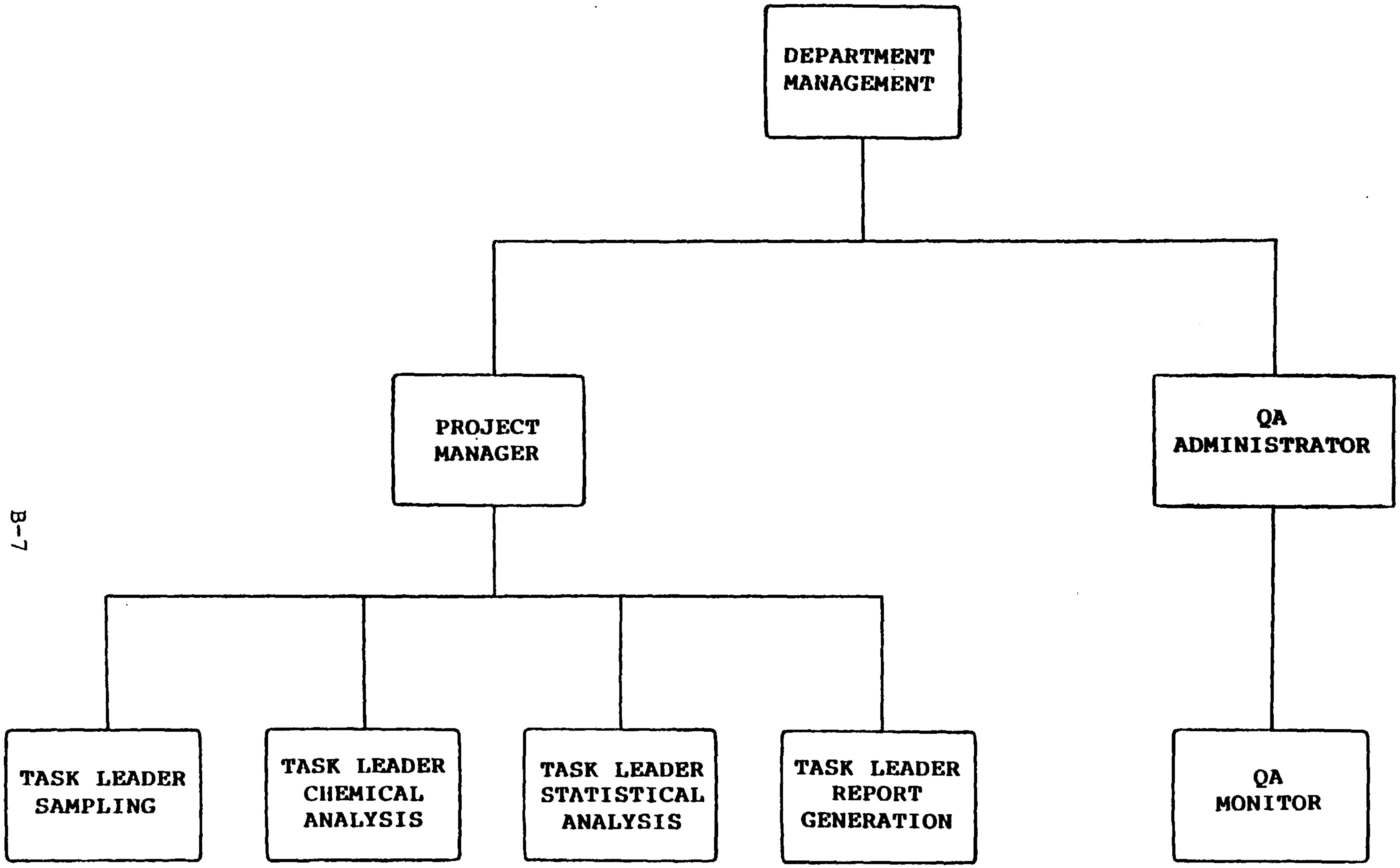


FIGURE 1. PROJECT ORGANIZATION

4.2.3 Project Manager

The Project Manager shall be responsible for coordinating sampling, chemical and statistical analyses, and report generation. Task Leaders may be appointed for these various tasks. The Project Manager shall assure that all personnel are fully informed of project QA policy and that any problems, deviations etc. are documented and corrective action is taken.

4.2.4 QA Monitor

The QA Monitor (QAM) shall:

- Plan the performance and systems audits.
- Closely monitor the results of the performance and systems audits.
- Communicate closely with the Project Manager.
- Periodically monitor and examine data books, forms, records, or any other hardcopy information.
- Determine and affirm data and sample traceability.
- Inform the Project Manager of any problems and request immediate corrective action.
- Screen data for transcription, calculation, or other errors.
- Provide monthly reports to the QAA.
- Provide documentation to the QAA affirming that the QA requirements of the project have been met.

5.0 QUALITY ASSURANCE OBJECTIVES

5.1 Accuracy

Transmission electron microscopy is the best available technique for measuring asbestos concentration because it provides a means of distinguishing asbestos fibers from non-asbestos fibers and also allows measurement of small as well as large individual fibers. Bundles or clusters of fibers are not included in the calculation of fiber or mass concentration because of the difficulty of assigning meaningful dimensions to these aggregates. Therefore, if bundles or clusters are present transmission electron microscopy (TEM), like any other optical technique, will tend to underestimate the mass concentration.

Subject to availability, National Bureau of Standards (NBS) standard filter preparations of known asbestos concentration will be used to assess the accuracy of the method. Since NBS standards have not been available previously there is little quantitative information on TEM accuracy.

5.2 Precision

Fiber counts by TEM can be expected to range from 1 to 1000. Thus, from 1 to 3 significant figures may be reported.

In the duplicate and replicate analyses, coefficients of variation (standard deviation divided by the mean) of the asbestos concentration are expected to be about 0.4 or below unless the concentrations are very low (<50 ng/m^3)[1].

---

[1] Constant, P.C. et al, 1983. Midwest Research Institute Airborne Asbestos Levels in Schools. Final Report. Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency. Contracts 68-01-5915 and 68-01-5848.

Sample sizes (see Section 6.0) have been selected to ensure that waste disposal site and background levels of asbestos fiber concentration will be estimated with reasonable precision. If the coefficient of total variation (standard deviation divided by the mean) is between 100 and 150% the estimated concentrations are expected[1] to have estimation errors[2] which are no greater than the true means ± 60%.[3]

5.3 Representativeness

The sampling plan specifies selection of background site and waste site monitoring locations to ensure representative measurements will be obtained. The background site should not be influenced by the waste site or other sources of asbestos. Air samples shall be taken at five sampling locations and at five sampling times within the waste site to capture both spatial and temporal variations in air levels.

5.4 Completeness

The most serious, and most difficult to control, cause of lost samples is human interference and vandalism. Sampling locations shall be chosen to minimize this risk. Loss of samples due to errors by the field sampling crew should not exceed 5 to 10 percent.

---

1 With probability greater than 90%.
2 The estimation error is defined here as the size of the 95% confidence interval which will be calculated from the observed data.
3 See Section V.A.2, "Number of Samples," and Appendix A of this report.

6.0 EXPERIMENTAL DESIGN

A single location at a background site and five locations at the waste disposal site will be selected. Air samples will be collected simultaneously at all six locations on five separate occasions. This will provide five background samples and 25 waste disposal site samples. This sampling plan is designed to encompass the expected spatial and temporal variability in asbestos concentration.

The sampling locations shall be chosen randomly within the constraints imposed by natural barriers and physical structures and so that any high concentrations of asbestos are likely to be sampled irrespective of wind direction or distance from an on-site 'source' (e.g., the disposal pit, roadways, the main landfill).

To determine the best type of filter, analytical treatment and pump flow rate, a pretest shall be carried out. The pretest will consist of three monitors at a single waste site location that is likely to produce high asbestos concentrations. Polycarbonate Nuclepore filters (0.4μm pore size) and three flow rates of 5, 10 and 15 lpm will be used for a 12-hour sampling period. The three pretest samples will be examined by an Electron Microscopy (EM) Laboratory with-without ashing or refiltering. If contamination by nonasbestos materials is still substantial at the lowest flow rate in the opinion of the electron microscopists, then the use of cellulose acetate Millipore (0.45μm pore size) filters and ashing/refiltering procedures will be necessary. Otherwise, the highest of the flow rates which still produces acceptable fiber identification and measurement should be selected for the monitoring study.

A summary of the experimental design is given in Table 1.

TABLE 1. EXPERIMENTAL DESIGN FOR AIR MONITORING STUDY

Site	Number of monitors	Sampling time	Flow Rates: Pre-test	Flow Rates: Study	Type of Filter: Pre-test	Type of Filter: Study	EM Sample Preparation: Pre-Test	EM Sample Preparation: Study
Waste	5	5 days @ 12 hrs/day	5, 10, & 15 ℓpm[a]	5, 10, or 15 ℓpm	Nuclepore	Nuclepore or Millipore[b]	Carbon coating only	Carbon coating only or preceded by ashing & refiltering[c]
Background	1	5 days @ 12 hrs/day	--	5, 10, or 15 ℓpm[a]	--	Nuclepore or Millipore[b]	--	Carbon coating only or preceded by ashing & refiltering[c]

[a] Depends on results of the pre-test, 15ℓpm recommended unless a lower rate elimates contaimination by organic materials.

[b] Use Nuclepore filters if nonasbestos contamination is not a problem (based on results of pre-test); otherwise, use Millipore filters.

[c] Use ashing and refiltering procedures if Millipore filters are used.

7.0 PERSONNEL QUALIFICATIONS

The personnel involved in this study should be experienced in field sampling, chemical and statistical analysis, and the associated QA requirements. The individuals should be identified and their qualifications described as part of the QA plan.

8.0 FACILITIES AND EQUIPMENT

The source of equipment for the field sampling should be specified in the QA plan. An EM laboratory with the appropriate microscope factilities shall be selected for analysis of air samples.

9.0 PREVENTIVE MAINTENANCE PROCEDURES AND SCHEDULES

The air sampling pump, which is the major sampling equipment item, is a diaphragm type pump which is essentially maintenance-free. Maintenance consists of a check prior to departure. If necessary, diaphragms are changed.

Maintenance records shall be maintained in appropriate notebooks.

10.0 CONSUMABLES AND SUPPLIES

The only major consumable items are the filters for the air pumps. If possible, all filters will be selected from the same lot; the numbers of the box and lot from which each filter is taken shall be recorded in the sampling logbook. Laboratory filter blanks will be used to check for contamination of the filter as described in Section 16.0.

11.0 DOCUMENTATION

All documentation in logbooks and other documents shall be in ink. If an error is made, it shall be corrected by crossing a line through the error and entering the correct information. Changes shall be dated, initialed, and the reason for the correction stated. The original entry must remain legible.

Details of field sampling, summaries of performance and system audits, sample transfer, results of QA analyses, etc., will be documented in appropriate laboratory notebooks and reports to management as described in the succeeding sections.

12.0 DOCUMENT CONTROL

Documents, such as this QA plan, shall be identified by

- Section number
- Revision number
- Date
- Page number

in the top right-hand corner of each page.

The Project Manager shall be responsible for ensuring that data books, notes, records, etc., pertaining to field sampling, results of chemical analyses and computer files used for statistical analyses are properly documented and stored.

The QA monitor, shall keep copies of traceability documents, random number codes applied to samples, summaries of the results of system and performance audits and other materials documenting the implementation of the QA plan.

All documents shall be retained for five years. After five years a decision will be made concerning which, if any, documents shall be retained for a longer period.

13.0 CONFIGURATION CONTROL

Air pumps will be placed according to the protocol given in Section 14.1, and regularly checked by the field sampling leader.

14.0 SAMPLE COLLECTION

Airborne asbestos sampling will be conducted according to the general procedure outlined elsewhere[1]. This will involve samples taken at both background and waste disposal sites as specified in the sampling plan.

14.1 Selection of Sampling Location

Since the air samples collected should be representative of typical concentrations at each site, they must capture both spatial and temporal variations in air levels. For the waste disposal site, five sampling locations and five sampling times shall be collected, thus making a total of 25 separate samples. The sampling locations shall be randomly selected within the following constraints: all locations should be at least 30m from the boundaries of the site (to assure that measurements reflect emissions from "sources" at the site), and the set of five locations should be approximately symetrical so as to capture high concentration irrespective of wind direction or distance from individual "sources" (e.g., the disposal pit, roadways, the main landfill).

For the background site, a single monitor operated for the same five time periods is desirable. A single monitor will suffice since temporal variability is likely to be greater than

[1] "Airborne Asbestos Levels in Schools: A Design Study," by B. Price, C. Melton, E. Schmidt, and C. Townley, dated November 20, 1980, a special project report prepared by Battelle's Columbus Laboratories under EPA Contract No. 68-01-3858.

spatial variability there. The specific location of the monitor will be governed by the usual considerations of security, access, and power availability. Locations near sources of dust should be avoided to prevent overloading of filters with particulate matter.

14.2 Sampling Times and Volumes

Based on the likelihood of day-to-day variability in on-site activity and meteorological conditions, sampling should be conducted on five separate days. Sampling periods of 12 hours for the waste site monitors and background monitors shall be used. The start and end hours for the 12-hour sampling period should be timed to coincide with the start and end hours of the day work shift at the Johns-Manville plant. These sampling periods should smooth out hourly variability in asbestos levels. Where possible, days with different wind speed and direction should be chosen. In all cases, days with rain or days following precipitation by less than 24 hours should be avoided.

The total volume of air to be sampled is dictated by (1) the lower detection limit of the analytical methodology,[1] (2) total concentrations of particulate matter at the sites (and, thus, the potential for overloading filters), and (3) accepted operating practices for sampler flow rates and filter face velocities for

---

[1] At least 10 asbestos fibers should be counted during EM examination. (USEPA 1978. U.S. Environmental Protection Agency. Electron Microscope Measurement of Airborne Asbestos Concentrations, A Provisional Methodology Manual. Research Triangle Park, NC: Office of Research and Development, U.S. Environmental Protection Agency. EPA 600/2-77-178.)

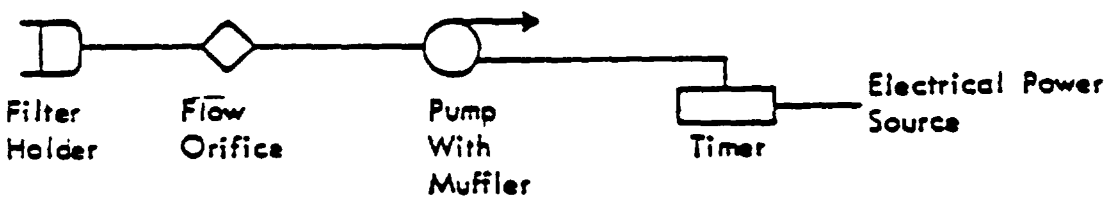
airborne asbestos monitoring[1]. The flow rates shall be selected based on the results of the pretest as described in Section 6.0.

14.3 Sampler Setup

The sampling system consists of:

1. An open-face filter holder.
2. A control flow orifice.
3. A pump with muffler.
4. Associated plumbing and stand.
5. A method of measuring sampling time.

The sampler setup is schematically represented as follows.



14.4 Sampling Protocol

1. Clean and dry filter holder and place in horizontal position.
2. Place filter in holder, assuring proper position (see filter handling section) and clamp filter in place. For Nuclepore filters at least two 47 mm cellulose acetate (Millipore type HA) filters with 5 μm pore size should be used as support.

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1 Yamate, G. 1981. Illinois Institute of Technology Research Institute. Methodology for the measurement of airborne asbestos by electron microscopy. Draft Report. Research Triangle Park, NC: U.S. Environmental Protection Agency. Contract 68-02-3266.

3. Rotate filter holder such that filter is in a vertical position (perpendicular to ground).
4. Start pump, check to see that filter is not wrinkled,and put top on filter holder.
5. Check plumbing for any leaks and check filter holder to assure that it is free from vibration.
6. Check flow with flowmeter with the timer control set on manual.
7. Set automatic timer to correct date and time and set on/off trippers to desired on-off time settings.
8. Make appropriate logbook entries.
9. Conduct sampling.
10. After sampling period, check flow, leave pump running.
11. Rotate filter to horizontal position, stop pump and remove filter. Attach Millipore or Nuclepore filter to a petri dish with tape and cover with lid for proper handling and transport. Number petri dish.

14.5 Filter Handling Procedures

1. Handle the filters by forceps (not with fingers) during loading and unloading of the filter holders.
2. After sampling, place the exposed filter in the petri holder (Millipore filters) exposed side up and maintain in that position during the handling and transport of the samples to the laboratory.

3. Hand-carry the samples in a container to the laboratories doing the chemical analyses.
4. Handle the container in a way that will keep the petri holders and the Nuclepore filter cassettes in a horizontal (flat) position at all times (handling, transport, and storage).

14.6 Laboratory Blanks

Use filters from the same production lot number, if possible. Prior to field sampling, select six filters (at least one per box) to serve as laboratory blanks and keep in laboratory until analysis. These blanks are used to check that the fibers are not contaminated prior to,or after sampling.

14.7 Field Blanks

During each of the five sampling periods, randomly select one field blank (filter) from a new box of filters at each sampling site (i.e., waste disposal and background sites). This will results in a total of 10 field blanks. Encode and handle the blank filters according to the same protocol as the test filters.

14.8 Log-Book Entries

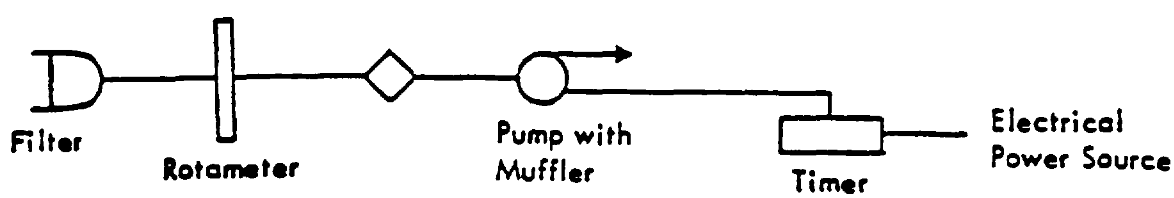
An important part of any field program are the observations and accurate records of the field team. As a minimum, logbook entries shall include:

1. Name of field operator.
2. Date of record.
3. Number and location of site.
4. Position of sampler within site.
5. Brief site description (sketch).
6. Filter number.
7. Identification numbers of pump, timer and filter holder.
8. Sample flow rate at start of sampling period.
9. Start time.
10. Stop time.
11. Sample flow rate at end of sampling period.
12. Wind rose for the sampling period.
13. Description of meteorological conditions.
14. Comments.

14.9 Procedure for Measuring Flow in the Field

This procedure describes the process used to determine the sample flow rates through the filters used to collect asbestos fibers in ambient air:

1. Set up the sampling system as shown below with the rotameter positioned as shown below.



2. Turn on the pump and with the filter in place, record the rotameter reading in the notebook.
3. Turn off the pump and remove the rotameter from the sampler.
4. Reconnect all tubing.
5. The sampler is ready to operate.
6. Repeat procedures 1 through 3 at the end of the sampling period.
7. Calculate the flow as follows:
   a. Using the calibration curve for the rotameter, determine the flow rates for each rotameter reading and record these values on the data sheet.
   b. Calculate the average flow rate for the sampling period using the following equation:

$$\text{average flow rate} = \frac{(\text{initial flow rate} + \text{final flow rate})}{2}.$$

   c. Calculate the actual volume of sample collected by multiplying the average sample rate by the sampling time.

15.0 SAMPLE CUSTODY

Sample traceability procedures described herein will be used to ensure sample integrity.

1. Each sample (filter) shall be issued a unique project identification number as it is removed from the pump. This number shall be recorded in a logbook along with the following information:
   a. Name and signature of field operator.
   b. Lot or assigned batch number (or any other identifiable number).
   c. Filter type (e.g., Millipore, Nuclepore).
   d. Date of record.
   e. Site (background or waste-disposal).
   f. Location of sampler within site.
   g. Use of filter, i.e., field blank, lab blank or test filter.
   h. Condition of sample.
   i. Sample flow rate at start of sampling period.
   j. Start time.
   k. Stop time.
   l. Sample flow rate at end of sampling period.
   m. Any specific instructions/comments.
2. A traceability packing slip shall be filled out in the field.

3. The samples shall be hand-carried to the laboratory responsible for chemical analysis where the package contents shall be inventoried against the traceability packing slip.

4. A copy of the inventory sheets shall be sent to the QA monitor. The original will remain in the field sampling leader's project files. A set of random numbers shall be generated and assigned sequentially to each sample replacing the field identification numbers. The relationship between the two sets of numbers shall be recorded and a copy retained by the QAM. Warning labels (if appropriate) will be affixed.

5. In order to maintain traceability, all transfer of samples (e.g., to other laboratories for QA analysis) shall be recorded in an appropriate notebook. The following information shall be recorded:

   a. The name of the person accepting the transfer, date of transfer, location of storage site, and reason for transfer.

   b. The assigned sample code number, which remains the same regardless of the number of transfers.

After the samples are properly logged in they will be placed in suitable storage areas. These areas will be identified as to the hazard they present to the samples.

16.0 SAMPLE ANALYSIS PROCEDURES

All air samples shall be hand-carried to the laboratory carrying out the chemical analysis and shall be kept encoded during microscopy analyses. They shall be decoded by the QA monitor after all analyses are completed.

Upon receipt of filters the laboratory shall record in a laboratory logbook the sample numbers, date they were received, and any macroscopic identifying characteristcs of particular filter samples. This includes damaged or smudged areas on the filter surface, lack of uniform sample deposition, unattached particulate or debris, unusually heavy-appearing deposit concentration, or other evidence of unusual condition.

Any damaged areas removed prior to sample preparation shall be mounted on glass slides using double-sided adhesive and the diameter of the effective filter area shall be measured. The total effective filter area and damaged areas of sample removed should be accurately recorded for subsequent calculation of asbestos concentrations.

Analysis shall be by transmission electron microscopy according to the methodology recommended by EPA [1,2].

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[1]USEPA. 1978. U.S. Environmental Protection Agency. Electron Microscope Measurement of Airborne Asbestos Concentrations, A Provisional Methodology Manual. Research Triangle Park, NC: Office of Research and Development, U.S. Environmental Protection Agency. EPA-600/2-77-178.

[2]Yamate, G. 1981. Illinois Institute of Technology Research Institute. Methodology for the measurement of airborne asbestos by electron microscopy. Draft Report. Research Triangle Park, NC: U.S. Environmental Protection Agency. Contract 68-02-3226

Two alternative sample preparation protocols are employed. The first is utilized when contamination by nonasbestos materials is not a problem and the sample is collected on polycarbonate Nuclepore filters. The second protocol is employed when the sample is collected on Millipore filters (cellulose acetate). Which protocol is employed will be determined by the outcome of the pretest, as discussed in Section 6.0. Both protocols are described below.

16.1 Sample Preparation

16.1.1 Samples on Millipore Filters

In the original sample dish, cut a 90 radial section of the original 47-mm filter sample with a clean, single-edged razor blade. Transfer the quarter section with stainless steel forceps to a clean 1 in. x 3 in. glass slide, and cut again into smaller wedges to fit into the glass ashing tube (approximately 15-mm long). Transfer the wedges by forceps to clean, numbered ashing tube. Place the tube in an LFE 504 low temperature plasma oven, one sample tube and one laboratory control tube per ashing chamber. The laboratory control tube may either contain a blank Millipore filter or be run as an empty tube. Maintain the ashing process at 450 watts for 2 hr.

Upon removal from the oven, treat the ashing tubes as follows. Place the tube in an ultrasonification bath. Pour 1 to 2 ml of 0.22 μm filtered Millipore-Q water into the tube from a clean 100 ml graduated cylinder. Sonicate (at 40 milliamperes) the sample vigorously for approximately 5 min and transfer it to a clean 150 ml glass beaker. Rinse the tube by additional ultrasonification two or three times more using a few milliters of filtered water each time, and transfer the contents to a 150 ml sample beaker. Add the remaining volume (up to 100 ml) of filtered water and sonicate again the entire suspended sample or blank, so that the total time of dispersion in the sonicator takes at least 20 min. Use a clean glass rod to stir the suspended sample while it is being sonicated.

Divide the 100 ml fraction into three aliquots: 10, 20, and 70 ml, prepared in that order. Using a 25-mm Millipore filter apparatus, place a 0.1 μm Nuclepore polycarbonate filter on top of an 8.0 μm mixed cellulose ester Millipore backup filter. Wet the filters by aspirating approximately 10 ml of filtered deionized water. Stop aspiration, pour in the first sample aliquot or portion thereof, and begin the aspiration procedure again. Carefully add the remaining sample volume without disturbing the flow across the Nuclepore filter surface. The suspended sample may be resonicated or stirred between filtration of the aliquots.

When the sample is deposited, carefully transfer the Nuclepore filter to a clean, labeled (sample number, date, and aliquot size) 1 x 3 in glass slide. Discard the Millipore backup filter.

When dry, attach the 0.1 μm Nuclepore filter tautly to the slide with transparent tape. Coat the filter with an approximately 40-nm-thick carbon film (national Spectroscopic Laboratories carbon rods) by vacuum evaporation. The film thickness need be sufficient only to provide support for the deposit sample.

Transfer the polycarbonate filter deposit to a 200-mesh electron microscope copper grid (E. G. Fullam) by first cutting a 3-mm-square portion from the filter using a clean, single-edged razor blade. Place this deposit side down on the electron microscope (EM) grid which, in turn, has been set upon a small, correspondingly labeled portion of lens tissue paper. Place the film, grid, and lens paper on a Jaffe dish consisting of a copper screen supported on a bent glass rod in a covered 90-mm glass petri dish. Pour reagent grade chloroform (J.T. Baker Company) into the dish to saturate the lens paper without submersing the grid and sample. Keep the dish covered at room temperature for 2 hr. Shift the prepared sample to a clean petri dish with fresh chloroform. Heat to 40°C for 10 min to provide a washing procdure.

While it is still wet, place the sample grid in a small gelatin capsule. Tape the capsule to the slide that has the remaining coated polycarbonate filter, and store until analysis.

16.1.2 Samples on Nuclepore Filters

The above ashing and refiltering procedures are unnecessary for samples collected directly on Nuclepore filters. Instead, the filter is carbon-coated and transferred to an EM grid as described in the preceding three paragraphs.

16.2 Microscopic Procedure

Select a sample or, for samples ashed and refiltered, start with the 70-ml aliquot of filtered material. Examine the EM grid under low magnification in the transmission electron microscope to determine its suitability for examination under high magnification. Ascertain that the loading is suitable and is uniform, that a high number of grid openings have their carbon film intact, and that the sample is not contaminated excessively with extraneous debris or bacteria.

Scan the EM grid at a screen magnification of 20,000X. Record the length and breadth of all fibers that have an aspect ratio of greater than 3:1 and have substantially parallel sides. Observe the morphology of each fiber through the 10X binoculars and note whether a tubular structure characteristic of chrysotile asbestos is present. Switch into selective area electron diffraction (SAED) mode and observe the diffraction pattern. Note whether the pattern is typical of chrysotile or amphibole, ambiguous, or neither chrysotile nor amphibole. Use energy dispersive X-ray analysis where necessary to further characterize the fiber. Take pictures as desired representing the sample type, fiber/particulate distribution, or characteristic SAED patterns of chrysotile and specific amphibole types.

Count the fibers in the grid openings until at least 100 fibers, or the fibers in a minimum of 10 grid openings, have been counted. Once counting of fibers in a grid opening has started, the count shall be continued though the total count of fibers may be greater than 100.

To ensure uniformity of grid opening dimensions, examine several 200-mesh grids by optical microscopy and measure roughly 100 opening per grid. Average these dimensions to provide a standard grid opening area.

16.3 Calculations

Calculate from the following equation, fiber number concentration expressed as the total number of fibers/volume of air:

$$\text{Fiber counts } (f/m^3) = (\text{number of fibers counted})\ (\text{area factor*}) \left(\frac{\text{dilution factors**}}{\text{volume sampled, } m^3}\right)$$

Calculate fiber mass for each type of asbestos in the sample by assuming that the breadth measurement is a diameter; thus, the mass can be calculated from:

$$\text{Mass } (\mu g) = \frac{\pi}{4} \cdot (\text{length, } \mu m) \cdot (\text{diameter, } m)^2 \cdot (\text{density, } g/cm^3) \cdot 10^{-6}$$

The density of chrysotile is assumed to be 2.6 g/cm^3, and of amphibole, 3.0 g/cm^3. The mass concentration for each type of asbestos is then calculated from:

$$\begin{array}{c}\text{Mass Concentration}\\ (\mu g/m^3)\text{ of a}\\ \text{Particular Type}\end{array} = \frac{\left(\begin{array}{c}\text{Total Mass of All}\\ \text{Fibers of that Type } (ug)\end{array}\right)(\text{area factor*})\ (\text{dilution factors**})}{\text{Volume of Air Sampled } (m^3)}$$

$$\text{*Area factor} = \frac{(\text{total effective filter area, } cm^2)}{(\text{number of grids examined})\ (\text{average area of an EM grid opening, } cm^2)}$$

**Dilution factors take into account sample dilution during ashing and refiltering and transfer to the EM grid. The factor = 1.0 for samples collected on Nuclepore filters. For the samples collected on Millipore filters, the factor = $[(\text{proportion of original filter ashed})\ (\text{aliquot volume,} cm^3/100\ cm^3)]^{-1}$

Record the fiber bundles and clusters as such, but do not include them in the mass calculation or the fiber count. The fiber clusters and fiber bundles are not included in the mass calculation because (1) it is difficult to assign the third dimension to the two-dimensional observation of the aggregates, (2) it is difficult to determine void space within bundles and clusters, and (3) since the bundles and clusters make up only about 2% of the item count, one cannot be certain of the even distribution throughout the filter.

16.4 Field Blanks

From the 10 field blanks, three shall be randomly selected by the QA monitor for chemical analysis to check for contamination. These three filters shall consist of one filter from the background site, and two from the waste-disposal site. The remaining 7 field blanks shall be kept for additional analyses, if necessary. If field blank contamination is detected, it may be appropriate to analyze one or more factory blanks to check whether the filters were contaminated prior to being taken into the field.

16.5 External Quality Assurance Filter Analysis

As a quality assurance measure, the QA monitor shall randomly select three samples to be analyzed by an external certified laboratory (QA laboratory). All filters selected for QA analysis shall be divided in half according to the analytical protocol for air samples and one half of each filter shall be hand-carried to the QA Laboratory. In addition, three laboratory blanks will be sent to the QA Laboratory and at least one of these will be analyzed by the QA Laboratory (see Section 16.7). The results from the QA laboratory will be compared with those from the primary laboratory. If serious discrepancies appear, additional filters should be analyzed.

16.6 Replicate and Duplicate Filter Analyses

As a means of quantifying in-house variability, and analytical variability introduced by the filter preparation procedure, samples shall be selected by the QA monitor for replicate and duplicate analyses. Replicate analysis shall be performed using two independent preparations from the same filter. Duplicate analyses shall be conducted by a second analyst using the same grid preparation as in the original analysis. For this purpose, filters shall be randomly selected from the remaining filters (i.e., those not chosen for external QA analysis). Three filters shall be selected for duplicate analyses and three for replicate analyses.

16.7 Laboratory Blanks

As a means of checking on possible contamination during the preparation procedures, at least three laboratory blank filters should be subjected to standard laboratory procedures during preparation and analysis of the samples. At least one of these is then analyzed to check for contamination in the laboratory. This procedure should be followed at both the main laboratory and at the external QA laboratory.

Table 2. Number and Types of Chemical Analyses

	Laboratory blanks	Field blank		Test filters		
		Background	Waste-Disposal	Background	Waste-Disposal	Total
Filters available for analysis	6	5	5	5	25	30
Filters actually analyzed	2[a]	1	2	5	25	30
Filters for external QA	See above					3
Filters for replicate analysis						3
Filters for duplicate analysis						3
Total number of chemical analysis	2	1	2			39

[a] One by main laboratory and one by external QA laboratory.

17.0 ROTAMETER CALIBRATION PROCEDURES AND REFERENCE MATERIALS

17.1 Rotameter Calibration Procedure

1. Record the preliminary data at the top of the data sheet shown in Figure 2.
2. Set-up the calibration system as shown in Figure 3. Allow wet test meter to run for 20 min. before starting the calibration.
3. Turn on the pump and adjust the flow until the pyrex ball is around 25 on the rotameter scale.
4. Record both the SS and pyrex ball values on the data sheet.
5. Measure the volume of air which passes through the rotameter during an accurately timed interval. Record the initial and final times and wet test meter readings.
6. Record the wet test meter temperature (Tw) and manometer readings (ΔP) during the time interval.
7. Run at least duplicates for each rotameter setting.
8. Reset the pyrex ball to around 90 and repeat Steps 4 through 7.
9. Reset the pyrex ball to around 120 and repeat Steps 4 through 7.
10. Calculate flow rates for each setting using the equation:

$$Q = \frac{(Vw \times Corr)}{Time} \left[\frac{(P_b - V_p) + \frac{\Delta p}{13.6}}{P_s} \right] \left[\frac{T_s}{T_w + 273} \right]$$

Flowmeter type ______________________ Tube ______________

I.D. no. ______________________ Date ______________

Barometric pressure, Pb ______________ "H_2O Initial ______________

Standard pressure, Ps ______________ "H_2O Standard temp, Ts ______ ° K

Test no.	Flowmeter ball, mm		Wet test meter (corr. =)					Q^b
	SS	Pyrex	Time min	Vw cc	ΔP "H_2O	Tw °C	Vp[a] "Hg	Flowrate Std cc/min

[a] From vapor pressure vs. temperature tables

$$^{b}Q = \frac{(Vw \times Corr.)}{Time}\left[\frac{(Pb - Vp) + \left(\frac{\Delta P}{13.6}\right)}{Ps}\right]\left(\frac{Ts}{Tw + 273}\right)$$

FIGURE 2. FLOWMETER CALIBRATION DATAFORM, > 1000 cc/min

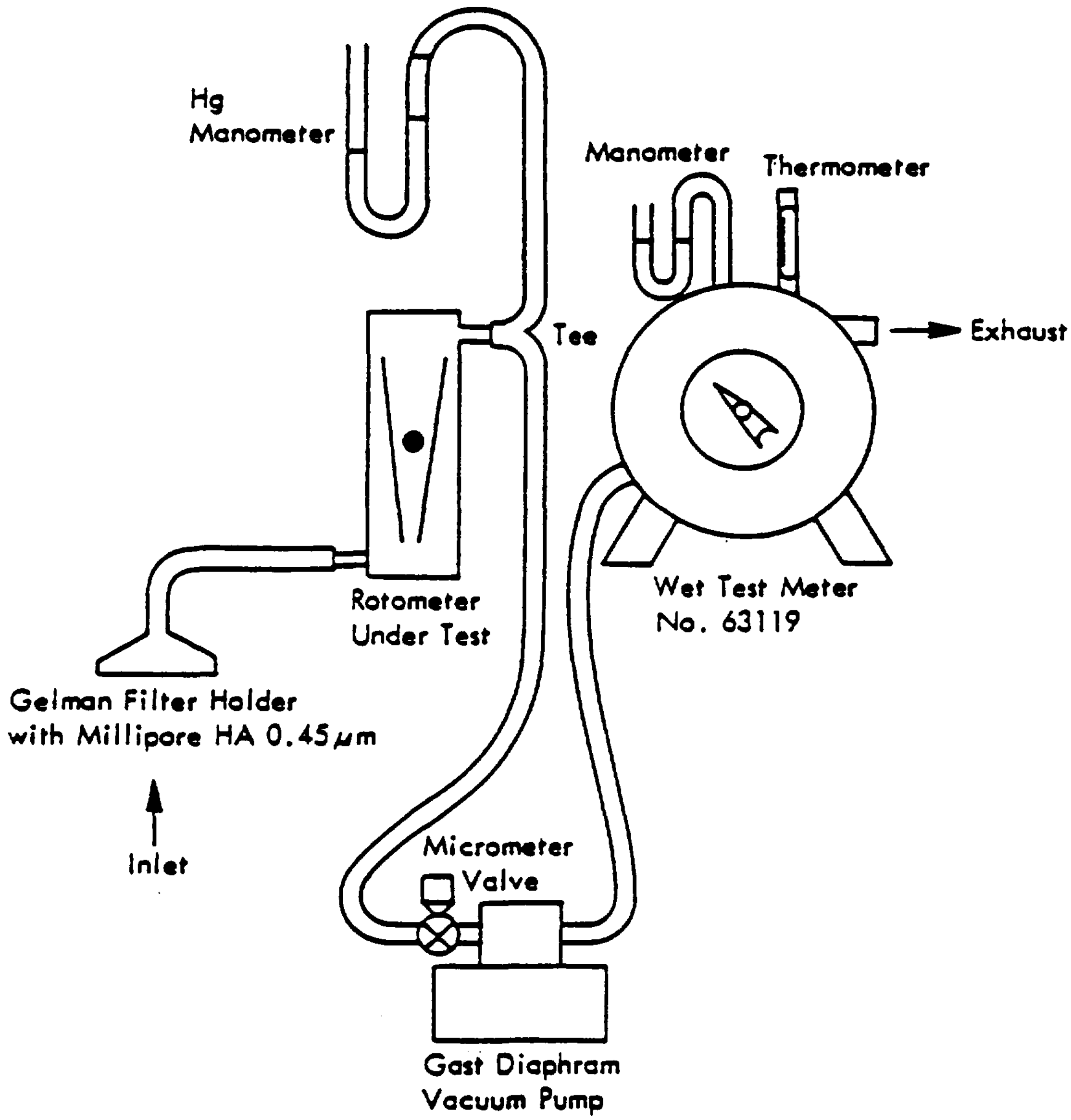

FIGURE 3. ROTAMETER CALIBRATION SYSTEM

where:

Q	= flow rate in standard cc/min,
V_w	= wet test meter volume in cc,
Corr.	=correction value obtained for each specific we test meter,
Time	=time in minutes,
P_b	=barometric pressure in inches of H_2O,
V_p	=vapor pressure in inches of H_g,
Δp	=manometer reading in inches of H_2O,
P_s	=standard pressure in inches of H_2O,
T_s	=standard temperature in ^oK, and
T_w	=wet test meter temperature in ^oC.

10. Plot rotometer readings versus values of Q for each setting as shown in Figure 4.

17.2 Rotameter Calibration Schedule

Rotameters shall be checked, cleaned if necessry, then calibrated prior to the first sampling trip.

17.3 Reference Materials

Standard materials of known asbestos type shall be used as references for fiber morphology and electron diffraction patterns.

Subject to availability, National Bureau of Standards standard filter preparations of known asbestos concentration will be used to assess the accuracy of the TEM method.

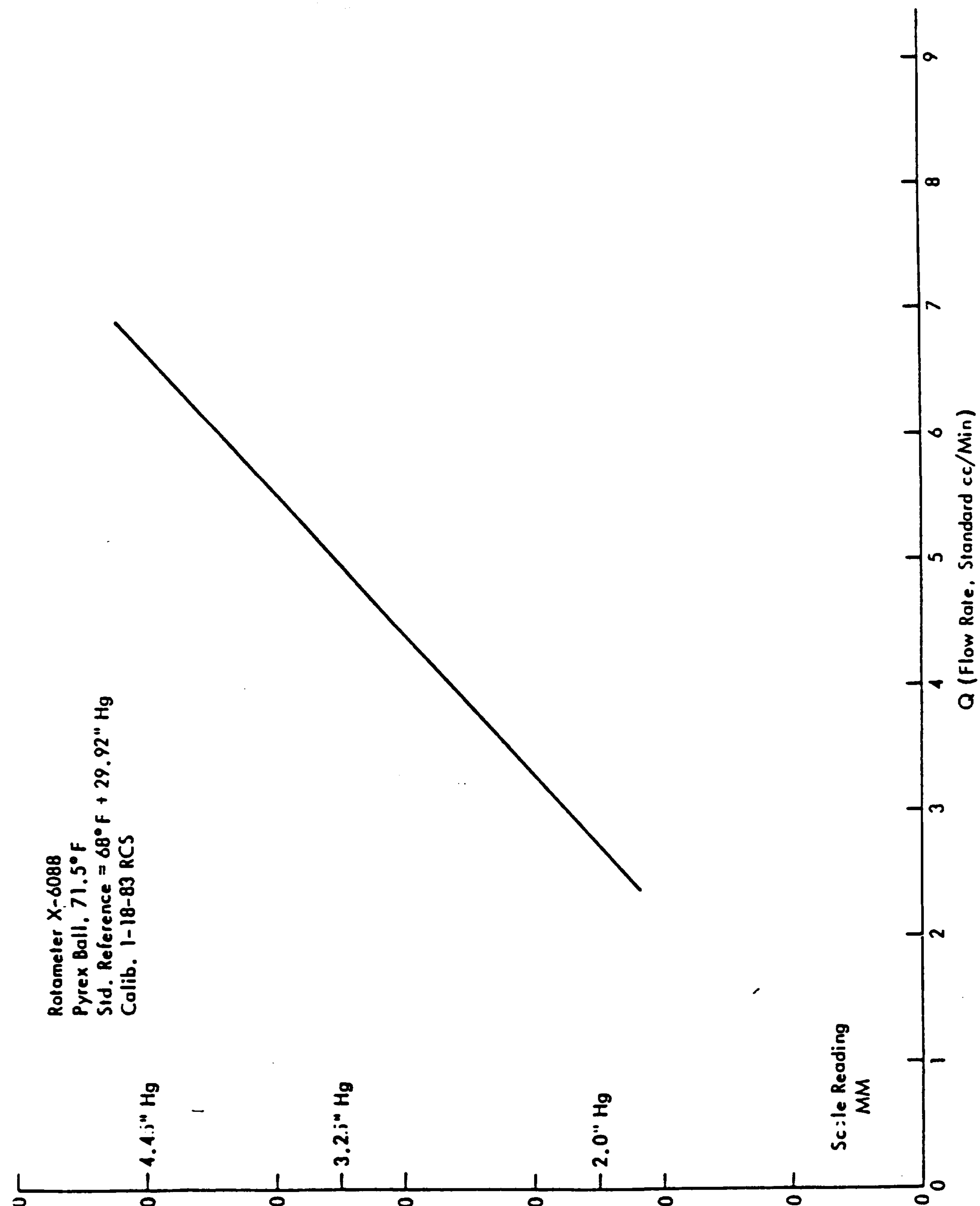

FIGURE 4. PLOT OF ROTAMETER READINGS VERSUS VALUES OF Q

18.0 DATA VALIDATION

As a minimum, the guidelines listed below should be followed:

- When calculations are made by hand, 2 people shall spot check some calculations independently and then compare results; correct, if necessary.
- When computer is used, data entry shall be verified; programs, formulae, etc..., shall be tested with sample data previously worked out by hand.
- When statistical software packages are used, tests of reason shall be applied; on outputs, double-check sample sizes, degrees of freedom, variable codes, etc...; be alert for outliers.
- When reporting numerical results, computer generated outputs rather than retyped tables shall be used to the extent possible. When possible, reported tables shall be compared for consistency in variable codes and values, sample sizes, etc...

In all cases, data validation activities shall be documented and records kept of any necessary corrective action in the appropriate notebook.

19.0 DATA PROCESSING AND ANALYSIS

Standard statistical techniques will be used to estimate mean airborne asbestos concentration for the waste disposal site and for the background site. A 95% confidence interval will be obtained to provide a measure of the error involved in the estimation. Comparisons between the disposal site and background concentrations will be made.

Power calculations shall be made to indicate the power of the statistical tests to detect differences between means.

The results from the various QA analyses (field blanks, external laboratory, replicate and duplicate analyses) will be compared with the appropriate original analyses. The small number of QA samples precludes formal statistical analysis. However, if inconsistencies or large discrepancies are observed, further QA samples can be analyzed since only a portion of each filter is needed for each analysis.

20.0 INTERNAL QUALITY CONTROL CHECKS

Internal quality control is achieved by the use of

- laboratory blanks (filters)
- field blanks (filters)
- external laboratory QA analyses
- replicate analyses
- duplicate analyses
- data entry checks
- data transfer checks

as described in Sections 14, 16 and 18.

21.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits provide the primary means for external monitoring for this project. These audits will be performed during the field sampling by an individual appointed by the QA monitor.

21.1 Performance Audits

Device to be Audited	Audit Device
Diaphragm pump	Calibrated rotameter

* Performance Audit Procedure
  - Verify calibration of the rotameter against standard reference device.
  - Review EPA standard methods and/or other test protocols.
  - Directly measure flow rate against rotameter.
  - Record all data on performance audit form. In general, all reported values should be within ± 10% as compared to the audit device.
  - Prepare and submit a summary report, and all records to the QA monitor.

21.2 System Audit

Area to be Audited	Audit Mechanism
Entire Sampling Procedure	Standard Audit Form

* System Audit Procedure

- Review test procedures and protocols.
- Obtain standard audit form.
- Observe the performance of each task.
- Ask questions as required.
- Take corrective actions as necessary.
- Fill in appropriate blank lines on audit form.
- Prepare and submit summary report, and all records to QA monitor.

22.0 DATA ASSESSMENT PROCEDURES

Precision of the data will be determined by performing replicate analyses or replicate sample preparation and analyses operations. The measurement for precision will be the coefficient of variation (standard deviation/mean). Tests for outliers will be performed on data obtained from the primary laboratory. Data from both the primary and external QA laboratories will be compared and checked for discrepancies.

23.0 FEEDBACK AND CORRECTIVE ACTION

The types of corrective action procedures which will be used for this program are:

- On-the-spot, immediate, corrective action.
- Closed-loop, long-term, corrective action.

23.1 On-the-Spot Corrective Action

This type of corrective action is usually applied to spontaneous, non recurring problems, such as an instrument malfunction. The individual who detects or suspects non-conformance to previously established criteria or protocol in equipment, instruments, data, methods, etc., immediately notifies his/her supervisor. The supervisor and the appropriate task leader then investigate the extent of the problem and take the necessary corrective steps. If a large quantity of data is affected, the task leader must prepare a memo to the Project Manager and the Quality Assurance Monitor. These individuals will collectively decide how to proceed. If the problem is limited in scope, then the task leader decides on the corrective action measure, documents the solution in the appropriate workbook and notifies the Project Manager, and the QA monitor in memo form.

23.2 Closed-Loop, Long-Term Corrective Action

Long-term, corrective action procedures are devised and implemented in order to prevent the re-occurrence of a potentially serious problem. The QAM is notified of the problem and conducts an investigation of the problem to determine its severity and extent. The QAM then files a corrective action request with the appropriate Task Leader, with a copy to the Project Manager, requesting that corrective measures be put into place. Suggestions as to the appropriate corrective action will also be made. The Task Leader is responsible for implementing any corrective actions. The QAM will conduct a follow-up investigation to determine the effectiveness of the corrective action.

24.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

In general, monthly summary reports to management shall include information from:

- Inspections, performance audits and/or systems audits.
- Reports and/or findings of irregularities or non-conformance to program quality policies.
- Status of solutions to any problem area.

Procedurally, the QA Monitor will prepare the reports to management. These reports will be addressed to the Project Manager and the QA administrator. The summary of findings shall be factual, concise and complete. Any required supporting information will be appended to the report.

25.0 REPORT DESIGN

The project report will contain the following sections:

(1) Executive Summary

(2) Overview of the Experimental Design

Background

Purpose and Objectives

Experimental Design

(3) Description of the Results

(4) Conclusions and

(5) Methodological Report

Experimental Design

Sampling Procedures

Chemical Analysis

Statistical Analysis

Data and Data File Documentation

This QA plan will be included as appendix together with documentation of any deviations from the plan. Results of analyses of external QA, replicate and duplicate analyses will be presented and discussed.